# NVM Express: SCSI Translation Reference

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# *Introduction*

## 1.1 Scope and Theory of Operation

This document defines an NVM Express translation reference for SCSI.  NVM Express defines a host controller interface and command set for use with non-volatile memory (NVM) devices, such as PCI Express solid state drives (SSDs).  There are existing applications and software infrastructure built upon the SCSI architectural model defined by T10.  The purpose of this document is to define a mapping between SCSI and NVM Express specifications to enable a seamless transition to NVM Express by preserving existing software infrastructure investments.

Host software implementing the mapping of SCSI commands into NVM Express commands may be logically viewed as a layer within the operating system stack.  Figure 1 depicts the SCSI to NVMe Translation Layer ("SNTL") pictorially.  The NVM Express Driver may implement the translation as an upper layer within the driver.

**Figure 1:  NVM Express SCSI Translation Driver Model**
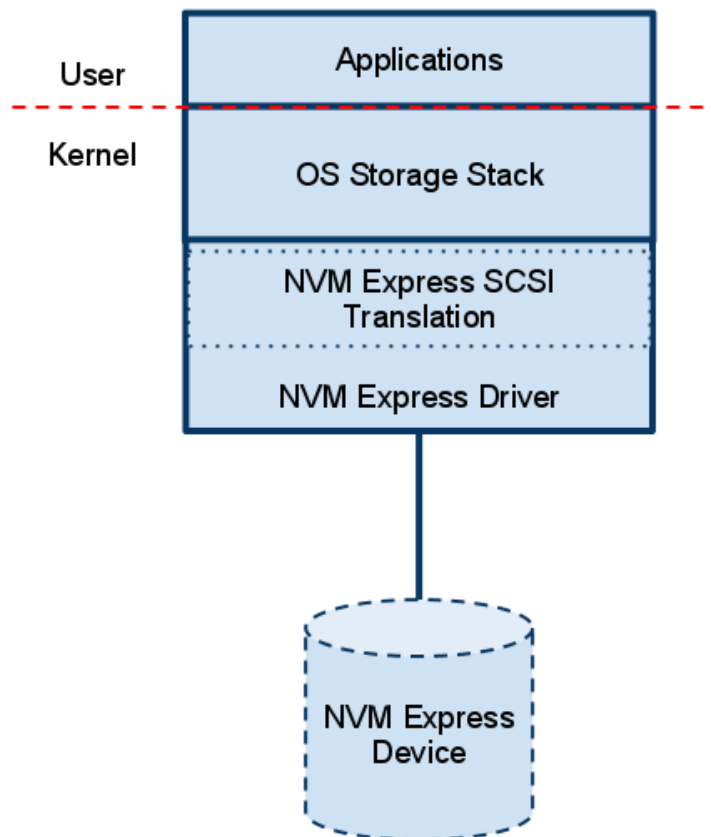
The translation layer exists logically below the operating system storage stack built upon SCSI and logically above the NVM Express driver implementing the NVM Express host interface.  Translation requires the mapping of:

- SCSI commands to NVM Express Commands.  Refer to Sections 2, 3, 4, 5.
- NVM Express Status to SCSI Status.  Refer to Section 7.

## 1.2  **Normative References**

The following standards are referenced within this document:

- ISO/IEC 14776-454, SCSI Primary Commands – 4 (SPC-4) [T10/1731-D]

- ISO/IEC 14776-323, SCSI Block Commands – 3 (SBC-3) [T10/1799-D]

- SCSI Architecture Model – 4 (SAM-4) [T10/1683-D]

- SCSI / ATA Translation – 3 (SAT-3)

- NVM Express 1.0b or later

## 1.3  **Terminology**

**Unspecified:** A term designating that this version of this reference does not specify a translation for a SCSI field. A translation for an unspecified field may be specified by future versions of this reference. Translation of fields marked unspecified shall not conflict with other standards in the set of SCSI standards.

**SNTL**: An acronym for SCSI to NVMe Translation Layer, the functional layer defined in this standard that uses an NVMe device to emulate objects in a SCSI logical unit, providing capabilities defined by SCSI standards (e.g., the SCSI Block Commands (SBC-3) and SCSI Primary Commands (SPC-4) standards).

# 2 Overview of Command Mappings

SCSI defines commands for an assortment of devices, some of which are not pertinent to NVM subsystems.  Figure 2 provides a summary of the SCSI commands that this reference document shall provide a translation for.  Translation of all other commands not listed in Figure 2 is unspecified.

Figure 2:  NVM Express SCSI Command Mappings

| SCSI Command | NVM Express Command(s) | Reference |
|---|---|---|
| COMPARE AND WRITE | Compare and Write | 5.1 |
| FORMAT UNIT | Format NVM | 5.2 |
| INQUIRY | Identify | 4.1 |
| LOG SENSE | Get Features, Get Log Page | 4.2 |
| MODE SELECT(6) | See Note 1 | 4.3 |
| MODE SELECT(10) | See Note 1 | |
| MODE SENSE(6) | Identify, Get Features | 4.4 |
| MODE SENSE(10) | | |
| READ(6) | Read | 5.3 |
| READ(10) | | |
| READ(12) | | |
| READ(16) | | |
| READ CAPACITY(10) | Identify | 5.4 |
| READ CAPACITY(16) | | |
| REPORT LUNS | Identify | 4.5 |
| REQUEST SENSE | See Note 1 | 4.6 |
| SECURITY PROTOCOL IN | Security Receive | 4.7 |
| SECURITY PROTOCOL OUT | Security Send | 4.8 |
| SEND DIAGNOSTIC | N/A | 4.9 |
| START STOP UNIT | Set Features, Get Features | 4.10 |
| SYNCHRONIZE CACHE(10) | Flush | 5.5 |
| SYNCHRONIZE CACHE(16) | | |
| TEST UNIT READY | See Note 1 | 4.11 |
| UNMAP | Dataset Management | 5.6 |
| VERIFY(10) | VERIFY | 5.7 |
| VERIFY(12) | | |
| VERIFY(16) | | |
| WRITE LONG (10) | Write Uncorrectable | 5.9 |
| WRITE LONG (16) | | |
| WRITE(6) | Write | 5.8 |
| WRITE(10) | | |
| WRITE(12) | | |
| WRITE(16) | | |
| WRITE BUFFER | Firmware Image Download, Firmware Image Activate | 4.12 |

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Notes:
1. MODE SELECT(6), MODE SELECT(10), REQUEST SENSE and TEST UNIT READY commands do not map 1-to-1 to NVM Express commands; a device driver should translate as specified in the referenced sections.

# 3 Common SCSI Field Translations

This section specifies the translation of common fields shared by multiple SCSI commands.

## 3.1 ALLOCATION LENGTH

ALLOCATION LENGTH is specified (SPC-4) as indicating number of bytes allocated by the application client in Data-in buffer for parameter data. Support for this field requires ensuring accesses to Data-in buffer are within the range defined by the ALLOCATION LENGTH.

## 3.2 BYTCHK

Support requires translation to FUA field of the NVM Express command.

## 3.3 CONTROL

| Bit Field | Notes |
|---|---|
| NACA (bit 2) | If set to 1b, command shall be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. (Note: section 6.1.1 requires that the NORMACA bit in Standard Inquiry data be set to 0b). |
| All others | Unspecified. |

## 3.4 DPO

Support unspecified. Disable page out (DPO) specifies retention characteristics which are not supported in NVM Express.

## 3.5 GROUP NUMBER

Support unspecified.

## 3.6 FUA

Support requires translation to FUA field of NVM Express command.

## 3.7 FUA_NV

Support unspecified. FUA_NV requests that data to be read from non volatile cache.

## 3.8 LOGICAL BLOCK ADDRESS

Support requires translation to Starting LBA field of NVM Express command.

## 3.9  PARAMETER LIST LENGTH

PARAMETER LIST LENGTH is specified (SPC-4) as indicating number of bytes allocated by the application client in data-out buffer for MODE SELECT parameter data, which shall include header, block descriptor(s) and mode pages.  Support for this field requires ensuring accesses to Data-out buffer are within the range defined by the PARAMETER LIST LENGTH.

## 3.10  PRODUCT IDENTIFICATION

Shall be set to the first 16 bytes of the Model Number (MN) field within the Identify Controller Data Structure.

## 3.11  PRODUCT REVISION LEVEL

Shall be set to the last 4 ASCII graphic characters in the range of 21h-7Eh (i.e. last 4 non-space characters) of the Firmware Revision (FR) field within the Identify Controller Data Structure.

## 3.12  IMMED

| CODE | Notes |
|------|-------|
| 0b | Shall be supported by returning status after command is complete. |
| 1b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |

## 3.13  T10 VENDOR IDENTIFICATION

Shall be set to "NVMe" followed by 4 spaces:  "NVMe    ".

## 3.14  TRANSFER LENGTH

Support requires translation to Number of Logical Blocks (NLB) field of NVM Express command.  Note that for SCSI commands with values of TRANSFER LENGTH greater than $2^{16}$, multiple NVM Express commands may need to be issued to satisfy the request.

## 3.15  VENDOR SPECIFIC IDENTIFIER

This field has a size of 36 bits.

## 3.16  VERIFICATION LENGTH

Support requires translation to Number of Logical Blocks (NLB) field of the NVM Express command.

## 3.17  VRPROTECT

Support for VRPROTECT requires setting PRACT and PRCHK fields of the NVM Express command:

**If BYTCHK set to zero:**

| VRPROTECT CODE | PRACT | PRCHK |
|---|---|---|
| 000b, 001b, 101b | 1 | 111b |
| 010b | 1 | 011b |
| 011b | 1 | 000b |
| 100b | 1 | 100b |

**If BYTCHK set to one:**

| VRPROTECT CODE | PRACT | PRCHK |
|---|---|---|
| 000b | 1 | 111b |
| 001b, 010b, 011b, 100b, 101b | 1 | 000b |

## 3.18 WRPROTECT

Support for WRPROTECT requires setting PRACT and PRCHK fields of the NVM Express command:

| WRPROTECT CODE | PRACT | PRCHK |
|---|---|---|
| 000b | 1 | 000b |
| 001b, 101b | 0 | 111b |
| 010b | 0 | 011b |
| 011b | 0 | 000b |
| 100b | 0 | 100b |
| All other codes shall result in command termination with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. | | |

# *4  SCSI Primary Command Mappings*

This section defines the translation of SCSI commands applicable to all SCSI devices into NVM Express commands and structures.

## 4.1  **INQUIRY (SPC-4)**

A SCSI INQUIRY command shall be translated into an NVM Express Identify command.  The INQUIRY command requests information regarding the device.  The type of information to return is indicated in the EVPD and PAGE CODE fields of the INQUIRY command.  Table 4-1 specifies the translation of INQUIRY fields.

**Table 4-1:  INQUIRY CDB Field Translation**

| INQUIRY Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as 12h (SBC-3). | |
| EVPD (Enable vital product data) | **CODE** | **Notes** |
| | 0b | Shall be supported by returning Standard INQUIRY Data to application client, refer to 6.1.1. |
| | 1b | Shall be supported by returning Vital Product Data to application client, refer to PAGE CODE field. |
| PAGE CODE | **CODE** | **Notes** |
| | 00h | Shall be supported by returning Supported VPD Pages data page to application client, refer to 6.1.2. |
| | 80h | May be supported by returning Unit Serial Number data page to application client.  Refer to 6.1.3. |
| | 83h | Shall be supported by returning Device Identification data page to application client, refer to 6.1.4. |
| | 86h | May be supported by returning Extended INQUIRY data page to application client, refer to 6.1.5. |
| | B0h | May be supported by returning Block Limits VPD data page to application client, refer to 6.1.6. |
| | B1h | May be supported by returning Block Device Characteristics VPD Page to application client, refer to 6.1.7. |
| | B2h | May be supported by returning Logical Block Provisioning VPD Page to application client, refer to 6.1.8. |
| | All Others | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |

| ALLOCATION LENGTH | Refer to 3.1. |
|---|---|
| CONTROL | Refer to 3.3. |

## 4.2 **LOG SENSE (SPC-4)**

LOG SENSE is used by application clients to retrieve statistical and operational information.

**Table 4-2: Translation of LOG SENSE**

| LOG SENSE Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as 4Dh (SPC-4). | |
| SP | **Code** | **Notes** |
| | 0b | Shall be supported by performing LOG SENSE command. Log parameters shall not be saved. |
| | 1b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| PC | **Code** | **Notes** |
| | 01b | Cumulative values shall be returned to application client. |
| | All Others | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| PAGE CODE | **Code** | **Notes** |
| | 00h | Shall be supported by returning Supported Log Pages log page to application client.  Refer to 6.2.1. |
| | 0Dh | Shall be supported by returning Temperature log page to application client.  Refer to 6.2.2. |
| | 11h | Shall be optionally supported by returning Solid State Media log page to application client. Refer to 6.2.3. |
| | 2Fh | Shall be supported by returning Informational Exceptions log page to application client.  Refer to 6.2.4. |
| | All Others | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| SUBPAGE CODE | Unspecified. | |
| PARAMETER POINTER | Unspecified. | |
| ALLOCATION LENGTH | Refer to 3.1. | |
| CONTROL | Refer to 3.3. | |

## 4.3 MODE SELECT(6), MODE SELECT(10) (SPC-4)

MODE SELECT is used by application clients to specify mode parameters.  The MODE SELECT command fields should be translated per Table 4-3.  Support for MODE SELECT(6) and MODE SELECT(10) also requires a device driver to translate mode parameter data as specified in 6.3.

**Table 4-3:  MODE SELECT Field Translations**

| MODE SELECT Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as (SPC-4): | |
| | **SCSI Command** | **OPERATION CODE** |
| | MODE SELECT(6) | 15h |
| | MODE SELECT(10) | 55h |
| SP | **CODE** | **Notes** |
| | 1b | Any saveable mode pages should be saved.  If the pages are not saved, then there is no distinction between current and saved pages |
| | 0b | Shall be supported.  There shall be no distinction between current and saved pages. |
| PF | **CODE** | **Notes** |
| | 1b | Indicates that the MODE SELECT parameters following the header and block descriptor(s) are structured as pages of related parameters and are defined in the SPC-4 standard. |
| | 0b | May result in command termination with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| PARAMETER LIST LENGTH | Refer to 3.9. | |
| CONTROL | Refer to 3.3. | |

## 4.4 MODE SENSE(6), MODE SENSE(10) (SPC-4)

MODE SENSE requests that mode parameters be returned to the application client.

**Table 4-4: MODE SENSE CDB Field Translations**

| MODE SENSE Field | Notes and References | | |
|---|---|---|---|
| OPERATION CODE | SPC-4 specifies this field as: | | |
| | **SCSI Command** | | **OPERATION CODE** |
| | MODE SENSE(6) | | 1Ah |
| | MODE SENSE(10) | | 5Ah |
| DBD | **CODE** | **Notes** | |
| | 0b | Shall be supported by returning zero or more block descriptors in the returned MODE SENSE data. | |
| | 1b | Shall be supported by not returning any block descriptors in the returned MODE SENSE data. | |
| LLBAA | If LLBAA is set to 1 then the LONGLBA field in the parameter data may be set to 1, if LLBAA is set to 0 then LONGLBA shall be set to 0. | | |
| PC | **CODE** | **Notes** | |
| | 00b | Shall be supported by returning current values in mode pages to application client. | |
| | 01b | Shall be supported by returning changeable values in modes pages to application client. | |
| | 10b | Shall be supported by returning default values in modes pages to application client. | |
| | 11b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. | |
| PAGE CODE | **CODE** | **Notes** | |
| | 01h | Shall be supported by returning Read-Write Error Recovery mode page, refer to 6.3.3.1. | |
| | 08h | Shall be supported by returning Caching mode page, refer to 6.3.3.2. | |
| | 0Ah | Shall be supported by returning Control mode page to application client, refer to 6.3.3.3 | |
| | 1Ah | Shall be supported by returning Power Condition Control mode page to application client, refer to 6.3.3.4. | |
| | 1Ch | Shall be supported by returning Informational Exceptions Control mode page to application client, refer to 6.3.3.7. | |
| | 3Fh | Subpage Code 00h shall be supported by returning all supported mode pages as defined in section 6.3.3.5 . | |
| | 3Fh | Subpage Code FFh shall be supported by returning all supported mode pages and subpages as defined in section 6.3.3.6. | |
| | All Others | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. | |
| SUBPAGE CODE | Unspecified. | | |
| ALLOCATION LENGTH | Refer to 3.1. | | |

| CONTROL | Refer to 3.3. |
|---|---|
| * MODE SENSE (10) only. | |

## 4.5  REPORT LUNS (SPC-4)

REPORT LUNS (SPC-4) returns a list of logical units to the application client.  The 4 least significant bytes shall be set to 0h.  Support for REPORT LUNS requires the Identify command and returning to the application client REPORT LUNS Parameter Data as specified in 6.6.

**Table 4-5: REPORT LUNS CDB Field Notes**

| REPORT LUNS Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as A0h (SPC-4). |
| SELECT REPORT | See Table 4-6. |
| ALLOCATION LENGTH | Refer to 3.1. |
| CONTROL | Refer to 3.3. |

**Table 4-6: REPORT LUNS SELECT REPORT CDB Field Notes**

| SELECT REPORT Field | Notes and References |
|---|---|
| 00h | Shall be supported by returning all namespaces accessible to host software as individual LUNs as per LUN LIST field description – see section 6.6. |
| 01h | Shall be supported by setting the LUN LIST LENGTH field to zero in the parameter data that is returned, indicating that there are no LUNs to report. This is not considered to be an error. |
| 02h | Shall be supported by returning all namespaces accessible to host software as individual LUNs as per LUN LIST field description – see section 6.6. |
| 10h | Shall be supported by setting the LUN LIST LENGTH field to zero in the parameter data that is returned, indicating that there are no LUNs to report. This is not considered to be an error. |
| 11h | If the LUN addressed in the command is LUN 0, Shall be supported by returning all namespaces accessible to host software as individual LUNs as per LUN LIST field description – see section 6.6. |
| | If the LUN addressed in the command is not LUN 0, Shall be supported by setting the LUN LIST LENGTH field to zero in the parameter data that |

| | |
|---|---|
| | is returned, indicating that there are no LUNs to report. This is not considered to be an error. |
| 12h | Shall be supported by setting the LUN LIST LENGTH field to zero in the parameter data that is returned, indicating that there are no LUNs to report. This is not considered to be an error. |
| All Others | Unspecified. |

## 4.6 **REQUEST SENSE (SPC-4)**

REQUEST SENSE requests that sense data be returned to application client.  Support requires returning sense data as defined in 6.5.

Table 4-7:  REQUEST SENSE CDB Field Translations

| REQUEST SENSE Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 03h (SPC-4). |
| DESC | <table><tr><td>**CODE**</td><td>**Notes**</td></tr><tr><td>1b</td><td>Shall be supported by returning descriptor format sense data to application client.  Refer to 6.5.2</td></tr><tr><td>0b</td><td>Shall be supported by returning fixed format sense data to application client.  Refer to 6.5.1.</td></tr></table> |
| ALLOCATION LENGTH | Refer to 3.1. |
| CONTROL | Refer to 3.3. |

## 4.7  SECURITY PROTOCOL IN (SPC-4)

The SCSI SECURITY PROTOCOL IN command is used to retrieve information regarding security protocols and previous SECURITY PROTOCOL OUT commands.  SECURITY PROTOCOL IN shall translate to an NVM Express Security Receive command.

Table 4-7: SECURITY PROTOCOL IN CDB Field Translations

| SECURITY PROTOCOL IN Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as A2h (SBC-3). |
| SECURITY PROTOCOL | Shall translate to Security Protocol field of NVM Express Security Receive command. |
| SECURITY PROTOCOL SPECIFIC | Shall translate to SP Specific field of NVM Express Security Receive command. |
| INC_512 | <table><tr><td>**CODE**</td><td>**Notes**</td></tr><tr><td>0b</td><td>Shall be supported.  Indicates ALLOCATION LENGTH field specifies number of bytes to transfer.</td></tr><tr><td>1b</td><td>Shall be supported.  Indicates ALLOCATION LENGTH field specifies increments of 512 bytes.</td></tr></table> |
| ALLOCATION LENGTH | Shall translate to Allocation Length field of NVM Express Security Receive command. |
| CONTROL | Refer to 3.3. |

## 4.8  SECURITY PROTOCOL OUT (SPC-4)

The SCSI SECURITY PROTOCOL OUT command is used to send data specifying operations to be performed.  SECURITY PROTOCOL OUT command shall translate to an NVM Express Security Send command.

**Table 4-8:  SECURITY PROTOCOL OUT CDB Field Translations**

| SECURITY PROTOCOL OUT Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as B5h (SBC-3). |
| SECURITY PROTOCOL | Shall translate to Security Protocol field of NVM Express Security Send command. |
| SECURITY PROTOCOL SPECIFIC | Shall translate to SP Specific field of NVM Express Security Send command. |
| INC_512 | <table><tr><th>CODE</th><th>Notes</th></tr><tr><td>0b</td><td>Shall be supported.  Indicates TRANSFER LENGTH field specifies number of bytes to transfer.</td></tr><tr><td>1b</td><td>Shall be supported.  Indicates TRANSFER  LENGTH field specifies increments of 512 bytes of data.</td></tr></table> |
| TRANSFER LENGTH | Shall translate to Transfer Length field of NVM Express Security Send command. |
| CONTROL | Refer to 3.3. |

## 4.9  SEND DIAGNOSTIC (SPC-4)

Since NVMe does not provide a method to request a self-test, this command shall be supported by taking no action and returning a GOOD status.

**Table 4-9: SEND DIAGNOSTIC Field Translations**

| SEND DIAGNOSTIC Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 1Dh (SPC-4). |
| SELF-TEST CODE | Shall be set to 000b. |
| PF | Page Format, shall be set to 0b. |
| SELFTEST | May be set to 0b or 1b. |
| DEVOFFL | SCSI target device offline, unspecified. |
| UNITOFFL | Unit offline, unspecified. |
| PARAMETER LIST LENGTH | Shall be set to 0h. |
| CONTROL | Refer to 3.3. |

## 4.10  START STOP UNIT (SPC-4)

START STOP UNIT requests that power states of the device transition to states specified by the command.  Support for START STOP UNIT requires Set Features, Get Features and power state transitioning.  Get Features and Set Features shall be used with namespace FFFFFFFFh.

**Table 4-10: START STOP UNIT CDB Field Translations**

| START STOP UNIT Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 1Bh (SBC-3). |
| IMMED | Refer to 3.12. |
| POWER CONDITION MODIFIER | Refer to Table 4-11. |
| POWER CONDITION | Refer to Table 4-11. |
| NO_FLUSH | If set to 0b a Flush command shall precede any command that may result from a START STOP UNIT translation. |
| LOEJ | Unspecified.  Indicates actions regarding loading or ejecting medium. |
| START | Refer to Table 4-11. |
| CONTROL | Refer to 3.3. |

**Table 4-11: Translation of Power States**

| POWER CONDITION | Name | POWER CONDITION MODIFIER | Notes | |
|---|---|---|---|---|
| 00h | START_VALID | 0h | **START Code** | **Notes** |
| | | | 01h | A Set Features command shall be issued specifying power state 0 |
| | | | 00h | A Set Features command shall be issued specifying the lowest power state supported as indicated in the Get Features command. |
| 01h | ACTIVE | 0h | A Set Features command shall be issued specifying power state 0. | |
| 02h | IDLE | 0h | A Set Features command shall be issued specifying power state 1. | |
| | | 1h | A Set Features command shall be issued specifying power state 2. | |
| | | 2h | A Set Features command shall be issued specifying power state 3. | |
| 03h | STANDBY | 0h | A Set Features command shall be issued specifying power state N-2, where N is the last power state supported. | |
| | | 1h | A Set Features command shall be issued specifying power state N-1, where N is the last power state supported. | |
| 07h | LU_CONTROL | 0h | Unspecified. | |

## 4.11 **TEST UNIT READY (SPC-4)**

TEST UNIT READY support requires a status to be returned to application client indicating the status of the logical unit.  If the NVM Express device is ready to accept commands a status of GOOD shall be returned, otherwise a status of CHECK CONDITION and a sense key of NOT READY shall be returned.

Table 4-12: TEST UNIT READY CDB Field Translations

| TEST UNIT READY Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 00h (SPC-4). |
| CONTROL | Refer to 3.3. |

## 4.12 **WRITE BUFFER (SPC-4)**

The SCSI WRITE BUFFER command is used for testing and downloading of microcode and errors.  Support for downloading of microcode requires the NVM Express Firmware Image Download and Firmware Activate commands.

Table 4-13: WRITE BUFFER CDB Field Translations

| WRITE BUFFER Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as 3Bh (SPC-4). | |
| MODE | | |
| | **CODE** | **Notes** |
| | 05h | Download microcode, save, and activate mode.  This mode shall be supported by issuing a Firmware Image Download command, followed by a Firmware Activate command. |
| | 07h | Download microcode with offsets, save, and activate mode. |
| | | If there is no knowledge of the total length of the image to be downloaded, the command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| | | If the total length of the image to be downloaded in multiple pieces is understood/determinable, this mode shall be supported by issuing a Firmware Image Download command and, after the entire image has been downloaded, a subsequent Firmware Activate command. |

| | 0Eh | Download microcode with offsets, save, and defer activate mode.  This mode shall be supported by issuing a Firmware Image Download command. |
| | 0Fh | Activate deferred microcode mode.  This mode shall be supported by issuing a Firmware Activate command. |
| | All others | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| BUFFER ID | Shall translate to Firmware Slot (FS) field of Firmware Activate command. | |
| BUFFER OFFSET | Shall translate to Offset (OFST) field of Firmware Image Download command. | |
| PARAMETER LIST LENGTH | Shall translate to Number of Dwords (NUMD) field of Firmware Image Download command.  Refer to 3.9. | |
| CONTROL | Refer to 3.3. | |

## 4.13 PERSISTENT RESERVE IN/OUT (SPC-4)

NVMe Reservation support was added in NVM-Express 1.1. A device based on this or a more recent specification identifies its support for these commands by setting IDENTIFY CONTROLER field ONCS bit 5. If the NVMe device does not support this optional command, the SNTL shall terminate SCSI Reservation commands with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID OPCODE additional sense code.

Prior to translating SCSI commands for reservations, the host should have set the Host Identifier (HOSTID) feature if applicable.  Refer to the NVMe specification.

Many NVMe reservation commands use a Reservation Type (RTYPE) field. This is translated from the SCSI RESERVATION TYPE value in Table 4-14, and is provided as reference for many of the Reservation translations.

Table 4-14: SCSI RESERVATION TYPE translation

| SCSI RESERVATION TYPE | NVMe RESERVATION TYPE (RTYPE) |
|---|---|
| 0h: No reservation | 0h: Not a reservation holder |
| 1h: WRITE EXCLUSIVE | 1h |
| 3h: EXCLUSIVE ACCESS | 2h |
| 5h: WRITE EXCLUSIVE-REGISTRANTS ONLY | 3h |

| 6h: EXCLUSIVE ACCESS – REGISTRANTS ONLY | 4h |
|---|---|
| 7h: WRITE EXCLUSIVE – ALL REGISTRANTS | 5h |
| 8h: EXCLUSIVE ACCESS- ALL REGISTRANTS | 6h |
| All Others | Reserved: if encountered as part of a PERSISTENT RESERVE OUT, the SNTL shall terminate the command with CHECK CONDTION status, ILLEGAL REQUEST sense key, and INVALID FIELD IN PARAMETER LIST additional sense |

### 4.13.1 **PERSISTENT RESERVE IN**

PERSISTENT RESERVE IN (SPC-4) is used to obtain information about persistent reservations and reservation keys (i.e., registrations) that are active within a device server. This command is used in conjunction with the PERSISTENT RESERVE OUT command (section 4.13.2).

The host shall support translating the SCSI CDB as defined in Table 4-15. See section 6.7 for details on filling the returned parameter list data for each Service Action.

**Table 4-15: PERSISTENT RESERVE IN CDB Field Translations**

| PERSISTENT RESV IN Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 5Eh (SPC-4). |
| SERVICE ACTION | |

| CODE | Notes |
|---|---|
| 00h | READ KEYS: Reads all registered reservation keys (i.e., registrations). This shall be translated using NVM Reservation Report command. Refer to section 6.7.1 for translation details. |
| 01h | READ RESERVATION: Reads the current persistent reservations. This shall be translated using NVM Reservation Report command. Refer to section 6.7.2 for translation details. |

| | | |
|---|---|---|
| | 02h | REPORT CAPABILITIES: Returns capability information. This shall be translated using Admin Identify Namespace and Get Feature commands. Refer to section 6.7.3 for translation details. |
| | 03h | READ FULL STATUS: Reads complete information about all registrations and the persistent reservations, if any. This shall be translated using NVM Reservation Report command. Refer to section 6.7.4 for translation details. |
| | 04h to 1Fh | Reserved. SNTL shall terminate the command with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID FIELD IN CDB additional sense code. |
| ALLOCATION LENGTH | Refer to 3.1. | |
| CONTROL | Refer to 3.3. | |

### 4.13.2 **PERSISTENT RESERVE OUT**

PERSISTENT RESERVE OUT (SPC-4) is used to request service actions that reserve a logical unit for the exclusive or shared use of a particular I_T nexus. The command uses other service actions to manage and remove such persistent reservations.

I_T nexuses performing PERSISTENT RESERVE OUT service actions are identified by a registered reservation key provided by the application client. An application client may use the PERSISTENT RESERVE IN command to obtain the reservation key, if any, for the I_T nexus holding a persistent reservation and may use the PERSISTENT RESERVE OUT command to preempt that persistent reservation.

The host shall support translating the SCSI CDB as defined in the following table. See section 6.7.5 for detailed translation for the command's Parameter List for each Service Action.

Table 4-16: PERSISTENT RESERVE OUT CDB

| PERSISTENT RESERVE OUT Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as 5Fh (SPC-4). | |
| SERVICE ACTION | | |
| | **CODE** | **Notes** |

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| | 00h | REGISTER: Register a reservation key with the device server or unregister a reservation key. This shall be translated into NVM Reservation Register command with IEKEY set to 0, RREGA set to either 000b (Register) or 001b (Unregister) depending on the service action (refer to 6.7.5). |
| --- | --- | --- |
| | 01h | RESERVE: Creates a reservation having a specified SCOPE and TYPE. This shall be translated into NVM Reservation Acquire command with IEKEY set to 0, and RACQA set to 000b (Acquire). |
| | 02h | RELEASE: Releases the selected reservation. This shall be translated into NVM Reservation Release command with IEKEY set to 0, and RRELA set to 000b (Release) |
| | 03h | CLEAR: Clears all reservation keys and reservations. This shall be translated into NVM Reservation Release command with IEKEY set to 0, and RRELA set to 001b (Clear) |
| | 04h | PREEMPT: Preempts persistent reservations and/or removes registrations. This shall be translated into NVM Reservation Acquire command with IEKEY set to 0, and RACQA set to 001b (Preempt). |
| | 05h | PREEMPT AND ABORT: Preempts persistent reservations and/or removes registrations and aborts all commands for preempted I_T Nexus. This shall be translated into NVM Reservation Acquire command with IEKEY set to 0, and RACQA set to 010b (Preempt and Abort). |
| | 06h | REGISTER AND IGNORE EXISITING KEY: Register a reservation key with the device server or unregister a reservation key. This shall be translated into NVM Reservation Register command with IEKEY set to 1 and RREGA set to either 000b (Register) or 001b (Unregister) depending on the service action (refer to 6.7.5). |
| | 07h | REGISTER AND MOVE: Register a reservation key for another I_T nexus with the device server and move a persistent reservation to that I_T nexus. This shall be translated into NVM Reservation Register command with IEKEY set to 0, and RREGA set to 010b (Replace). |

|  |  |  |
|---|---|---|
|  | 08h to 1Fh | Reserved. Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID FIELD IN CDB additional sense code. |
| TYPE | The host shall translate the SCSI TYPE to the NVM command's RTYPE field according to table 4-14 if used with NVM Reservation Acquire or Release command, and ignored otherwise. | |
| SCOPE | Only 00h is supported. If set to any other value, the SNTL shall terminate the command with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID FIELD IN CDB additional sense. | |
| PARAMETER LIST LENGTH | Refer to 3.9. | |
| CONTROL | Refer to 3.3. | |

# 5 SCSI Block Command Mappings

This section defines the translation of SCSI command set extensions for direct-access block devices into NVM Express commands and structures.

## 5.1 COMPARE AND WRITE (SBC-3)

Support for COMPARE AND WRITE requires support for the NVM Express Compare and Write fused operation and is indicated in bit 0 of the Fused Operation Support field of the Identify Controller data structure.

Table 5-1:  COMPARE AND WRITE CDB Field Translations

| COMPARE AND WRITE Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 89h (SPC-4). |
| FUA_NV | Refer to 3.7. |
| FUA | Refer to 3.6. |
| DPO | Refer to 3.4. |
| WRPROTECT | Refer to 3.15. |
| LOGICAL BLOCK ADDRESS | Refer to 3.8. |
| GROUP NUMBER | Refer to 3.5. |
| NUMBER OF LOGICAL BLOCKS | Shall be translated to Number of Logical Blocks field of the NVM Express Compare command. |
| CONTROL | Refer to 3.3. |

## 5.2   **FORMAT UNIT (SBC-3)**

Support for FORMAT UNIT requires the NVM Express Format NVM command and retention of NUMBER OF LOGICAL BLOCKS and LOGICAL BLOCK LENGTH mode parameter block descriptor fields as defined in 6.3.2.

**Table 5-2: FORMAT UNIT CDB Field Translations**

| FORMAT UNIT Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as 04h (SPC-4). |
| FMTPINFO | <table><tr><td>**CODE**</td><td>**Notes**</td></tr><tr><td>0b</td><td>Shall be supported by formatting unit without protection.</td></tr><tr><td>1b</td><td>May be supported if protection information is supported by formatting unit with protection information, refer to 5.2.1.  Otherwise command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code.</td></tr></table> |
| LONGLIST | LONGLIST shall be ignored if FMTDATA field is set to zero.  Otherwise: <table><tr><td>**CODE**</td><td>**Notes**</td></tr><tr><td>0b</td><td>Indicates a short parameter list header.</td></tr><tr><td>1b</td><td>Indicates a long parameter list header.</td></tr></table> |
| FMTDATA | Unspecified.  When set to 1b DEFECT LIST FORMAT is used. |
| CPMLST | Unspecified.  Indicates the type of defect list (complete list).  Ignored when FMTDATA is set to 1. |
| DEFECT LIST FORMAT | Unspecified.  If FMTDATA is 1, specifies format of address descriptors in defect list. |
| CONTROL | Refer to 3.3. |

### 5.2.1 FORMAT UNIT Parameter list

FORMAT UNIT Parameter list contains a header, an optional initialization pattern descriptor, and an optional defect list.

Table 5-3:  FORMAT UNIT Parameter List Header (long and short) Translations

| FORMAT UNIT Parameter List Header Field | Notes and References |
|---|---|
| PROTECTION FIELD USAGE | Refer to 5.2.1. |
| FOV | Unspecified |
| DPRY | Unspecified |
| DCRT | Unspecified |
| STPF | Unspecified |
| IP | Unspecified |
| IMMED | Refer to 3.12. |
| P_I_INFORMATION | SBC-3 specifies this as being set to zero. |
| PROTECTION INTERVAL EXPONENT | <table><tr><td>Code</td><td>Notes</td></tr><tr><td>0</td><td>Protection information interval shall equal the logical block length.</td></tr><tr><td>All others</td><td>Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code.</td></tr></table> |
| DEFECT LIST LENGTH | Unspecified |

### 5.2.1 Formatting with Protection Information

The type of protection to format a logical unit with is dependent upon the FTMPINFO field of FORMAT UNIT and the PROTECTION FIELD USAGE field of the FORMAT UNIT Parameter list.

Table 5-4:  PROTECTION FIELD USAGE and FMTPINFO Translations

| PROTECTION FIELD USAGE Code | FMTPINFO Code | Notes and References |
|---|---|---|
| 000b | 00b | Logical unit shall be formatted with type 0 protection.  Protection Information field of Format NVM shall be set to 000b. |
| 000b | 10b | Logical unit shall be formatted with type 1 protection.  Protection Information field of Format NVM shall be set to 001b. |
| 000b | 11b | Logical unit shall be formatted with type 2 protection.  Protection Information field of Format NVM shall be set to 010b. |
| 001b | 11b | Logical unit shall be formatted with type 3 protection.  Protection Information field of Format NVM shall be set to 011b. |

| All other values are unspecified. |
| --- |

## 5.3  READ(6), READ(10), READ(12), READ(16) (SBC-3)

Support for READ(6), READ(10), READ(12) or READ(16) requires an NVM Express Read command.

Table 5-5:  READ CDB Field Notes

| READ Field | Notes and References |
| --- | --- |
| OPERATION CODE | Specified as (SBC-3): <table><tr><td>**SCSI Command**</td><td>**OPERATION CODE**</td></tr><tr><td>READ(6)</td><td>08h</td></tr><tr><td>READ(10)</td><td>28h</td></tr><tr><td>READ(12)</td><td>A8h</td></tr><tr><td>READ(16)</td><td>88h</td></tr></table> |
| FUA_NV[*] | Refer to 3.7. |
| FUA[*] | Refer to 3.6. |
| DPO[*] | Refer to 3.4. |
| RDPROTECT[*] | Support for field requires setting PRACT and PRCHK of NVM Express read command: <table><tr><td>**RDPROTECT**</td><td>**PRACT**</td><td>**PRCHK**</td></tr><tr><td>000b</td><td>1</td><td>111b</td></tr><tr><td>001b, 101b</td><td>0</td><td>111b</td></tr><tr><td>010b</td><td>0</td><td>011b</td></tr><tr><td>011b</td><td>0</td><td>000b</td></tr><tr><td>100b</td><td>0</td><td>100b</td></tr></table> All other codes shall result in command termination with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| LOGICAL BLOCK ADDRESS | Refer to 3.8. |
| GROUP NUMBER[*] | Refer to 3.5. |
| TRANSFER LENGTH | Refer to 3.14. |
| CONTROL | Refer to 3.3. |
| [*] READ(10), READ(12), and READ(16) only | |

## 5.4 READ CAPACITY(10), READ CAPACITY(16) (SBC-3)

READ CAPACITY(10) and READ CAPACITY(16) requests that information regarding capacity and medium format be returned to application client.  Support for READ CAPACITY(10) and READ CAPACITY(16) requires an Identify command and returning READ CAPACITY Parameter Data as specified in 6.4.

**Table 5-6: READ CAPACITY CDB Field Translations**

| READ CAPACITY Field | Notes and References |
|---|---|
| OPERATION CODE | Specified as (SBC-3): <table><tr><td>**SCSI Command**</td><td>**OPERATION CODE**</td></tr><tr><td>READ CAPACITY(10)</td><td>25h</td></tr><tr><td>READ CAPACITY(16)</td><td>9Eh</td></tr></table> |
| SERVICE ACTION[*] | Set to 10h as specified in SPC-4. |
| LOGICAL BLOCK ADDRESS | Shall be set to zero when PMI bit is not obsolete and set to 0b, otherwise command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| ALLOCATION LENGTH[*] | Refer to 3.1. |
| PMI | This field is obsolete in some versions of SBC-3.  If not obsolete, this field shall be translated: <table><tr><td>CODE</td><td>Notes</td></tr><tr><td>0b</td><td>Shall be supported by returning information on the last logical block.</td></tr><tr><td>1b</td><td>Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code.</td></tr></table> |
| CONTROL | Refer to 3.3. |
| [*] READ CAPACITY (16) only | |

## 5.5 SYNCHRONIZE CACHE(10), SYNCHRONIZE CACHE(16) (SBC-3)

Support SYNCHRONIZE CACHE(10) and SYNCHRONIZE CACHE(16) requires an NVM Express Flush Command.  All command specific fields are unspecified.

## 5.6  UNMAP (SBC-3)

Support for UNMAP requires NVM Express Dataset Management command.

Table 5-7:  UNMAP CDB Field Translations

| UNMAP Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as 42h (SBC-3). | |
| ANCHOR | **CODE** | **Notes** |
| | 0b | Shall be supported by setting Attribute – Deallocate (AD) bit to 1b in NVM Express Dataset Management command |
| | 1b | Command permissible for resource-provisioned devices. |
| GROUP NUMBER | Refer to 3.5. | |
| PARAMETER LIST LENGTH | Refer to 3.9. | |
| CONTROL | Refer to 3.3. | |

### 5.6.1  UNMAP Parameter List

The parameter list specifies information regarding the block descriptors in Data-out buffer.

Table 5-8: UNMAP Parameter List

| UNMAP Parameter List Field | Notes and References |
|---|---|
| UNMAP DATA LENGTH | Specifies number of bytes in Data-out buffer. |
| UNMAP BLOCK DESCRIPTOR DATA LENGTH | Specifies number of bytes of UNMAP block descriptors in Data-out buffer. |

### 5.6.2  UNMAP Block Descriptor

The UNMAP Block Descriptor shall be translated into the Dataset Management Range Definition.  NOTE: In SCSI, LBAs are stored in big endian, whereas NVMe are stored little endian.

Table 5-9:  UNMAP Block Descriptor Field Notes

| UNMAP Block Descriptor Field | Notes and References |
|---|---|
| UNMAP LOGICAL BLOCK ADDRESS | Shall translate to Starting LBA field |
| NUMBER OF LOGICAL BLOCKS | Shall translate to Length in Logical Blocks field. |

## 5.7  VERIFY(10), VERIFY(12), VERIFY(16)(SBC-3)

Support for VERIFY(10), VERIFY(12) and VERIFY(16) requires a translation to the NVM Express Compare command.

**Table 5-10: VERIFY CDB Field Translations**

| VERIFY | Notes and References | | |
|---|---|---|---|
| OPERATION CODE | Specified as (SBC-3): | | |
| | SCSI Command | OPERATION CODE | |
| | VERIFY(10) | 2Fh | |
| | VERIFY (12) | AFh | |
| | VERIFY (16) | 8Fh | |
| VRPROTECT | Refer to 3.17. | | |
| DPO | Refer to 3.4. | | |
| BYTCHK | Refer to3.2 . | | |
| LOGICAL BLOCK ADDRESS | Refer to 3.8. | | |
| GROUP NUMBER | Refer to 3.5. | | |
| VERIFICATION LENGTH | Refer to 3.16. | | |
| CONTROL | Refer to 3.3. | | |

## 5.8  WRITE(6), WRITE(10), WRITE(12), WRITE(16) (SBC-3)

Support for WRITE(6), WRITE(10), WRITE(12), and WRITE(16) requires a translation to the NVM Express Write command.

Table 5-11:  WRITE CDB Field Translations

| WRITE | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as (SBC-3): | |
| | SCSI Command | OPERATION CODE |
| | WRITE(6) | 0Ah |
| | WRITE(10) | 2Ah |
| | WRITE(12) | AAh |
| | WRITE(16) | 8Ah |
| FUA_NV* | Refer to 3.7. | |
| FUA* | Refer to 3.6. | |
| DPO* | Refer to 3.4. | |
| WRPROTECT* | Refer to 3.18. | |
| LOGICAL BLOCK ADDRESS | Refer to 3.8. | |
| GROUP NUMBER* | Refer to 3.5. | |
| TRANSFER LENGTH | Refer to 3.14. | |
| CONTROL | Refer to 3.3. | |
| * WRITE(10), WRITE(12), and WRITE(16) only | | |

## 5.9  WRITE LONG(10), WRITE LONG(16) (SBC-3)

WRITE LONG requests that a logical/physical block be marked as containing an error, or transfer data to the medium.  Support requires the Write Uncorrectable command.

Table 5-12:  WRITE LONG CDB Field Translations

| WRITE LONG Field | Notes and References | |
|---|---|---|
| OPERATION CODE | Specified as (SBC-3): | |
| | **SCSI Command** | **OPERATION CODE** |
| | WRITE LONG(10) | 3Fh |
| | WRITE LONG(16) | 9Fh |
| SERVICE ACTION[*] | Shall be set to 11h as specified in SBC-3. | |
| COR_DIS | | |
| | **CODE** | **Notes** |
| | 1b | Shall be supported by issuing Write Uncorrectable command. |
| | 0b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| WR_UNCOR | | |
| | **CODE** | **Notes** |
| | 1b | Shall be supported by issuing Write Uncorrectable command. |
| | 0b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| PBLOCK | | |
| | **CODE** | **Notes** |
| | 0b | Shall be supported by issuing Write Uncorrectable command. |
| | 1b | Command may be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and ILLEGAL FIELD IN CDB additional sense code. |
| LOGICAL BLOCK ADDRESS | Refer to 3.8. | |
| BYTE TRANSFER LENGTH | Unspecified. | |
| CONTROL | Refer to 3.3. | |
| [*] WRITE LONG(16) only | | |

# 6  SCSI Data

Some SCSI commands use Data-in and Data-out buffers to return information to the application client, or to specify additional command parameters.  The content of Data-in and Data-out buffers when used in this manner is defined by SPC-4 and SBC-3.  This section describes support for SCSI data.

## 6.1  INQUIRY Data

### 6.1.1  Standard INQUIRY Data Page

Table 6-1: Translation of Standard INQUIRY data

| Standard INQUIRY data Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating support for PERIPHERAL DEVICE TYPE. |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device. |
| RMB | Shall be set to 0b indicating media cannot be removed. |
| VERSION | Shall be set to 06h indicating implementation of SPC-4. |
| NORMACA | Shall be set to 0b indicating an NACA bit set to 1 is unsupported and the ACA task attribute is unsupported. |
| HISUP | Shall be set to 1b indicating hierarchal addressing. |
| RESPONSE DATA FORMAT | Shall be set to 0010b indicating response data in SPC-4 format. |
| ADDITIONAL LENGTH | Shall be set to 1Fh indicating size of structure with no additional bytes. |
| SCCS | Shall be set to 0b indicating embedded storage arrays are unsupported. |
| ACC | Shall be set to 0b indicating access controls coordinator is unsupported. |
| TPGS | Shall be set to 0b indicating asymmetric LUN access is unsupported. |
| 3PC | Shall be set to 0b indicating third party copy commands are unsupported. |
| PROTECT | Shall use Identify Namespace Data Structure End to End Data Protection Type Settings (DPS) field to determine value: |

| | Identify DPS Value | PROTECT Value | |
|---|---|---|---|
| | 000b | 0b | |
| | All others | 1b | |
| ENCSEV | Shall be set to 0b indicating embedded enclosure services are unsupported. | | |
| MULTIP | Shall be set using bit 0 of Multi-Interface Capabilities field of the Identify Controller Data Structure. | | |
| ADDR16 | Shall be set to 0b indicating 16-bit wide SCSI addresses (SCSI Parallel Interface Specific INQUIRY data) are unsupported. | | |
| WBUS16 | Shall be set to 0b indicating 16-bit wide data transfers (SCSI Parallel Interface Specific INQUIRY data) are unsupported. | | |
| SYNC | Shall be set to 0b indicating synchronous data transfers (SCSI Parallel Interface Specific INQUIRY data) are unsupported. | | |
| CMDQUE | Shall be set to 1b indicating support for Command Management Model. | | |
| T10 VENDOR IDENTIFICATION | Refer to 3.12. | | |
| PRODUCT IDENTIFICATION | Refer to 3.10. | | |
| PRODUCT REVISION LEVEL | Refer to 3.11. | | |

### 6.1.2 Supported VPD Pages Data Page

**Table 6-2: Translation of Supported VPD Pages VPD Page**

| Supported VPD Pages Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating support for PERIPHERAL DEVICE TYPE connected to logical unit. |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device. |
| PAGE LENGTH | Shall be set to indicate number of items supported VPD pages list requires. |
| Supported VPD Page List | List of supported pages. |

## 6.1.3 Unit Serial Number VPD Page

The Unit Serial Number VPD page returns product serial number information to the application client. Support requires Identify Namespace Data Structure.

Table 6-3: Translation of Unit Serial Number VPD Page

| Unit Serial Number VPD Page Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating support for PERIPHERAL DEVICE TYPE connected to logical unit. |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device. |
| PAGE CODE | Set to 80h as defined in SPC-4. |
| PAGE LENGTH | See section 6.1.3.1. |
| PRODUCT SERIAL NUMBER | See section 6.1.3.1. |

### 6.1.3.1 PRODUCT SERIAL NUMBER and PAGE LENGTH fields

| NVMe EUI64 Field | NVMe NGUID Field | Notes and References |
|---|---|---|
| non-zero | zero | See section 6.1.3.1.2. |
| zero | non-zero | See section 6.1.3.1.1. |
| non-zero | non-zero | See section 6.1.3.1.1. |
| non-zero | zero | See section 6.1.3.1.2. |
| zero | zero | See section 6.1.3.1.3. (Note: This case valid for NVMe 1.0 devices only.) |

#### 6.1.3.1.1 NGUID-based Translation

**PAGE LENGTH** shall be set to 40 indicating the page length in bytes.
**PRODUCT SERIAL NUMBER** shall be set to a 40 byte value by translating the NGUID field of the Identify Namespace Data Structure.  The NGUID field shall be translated by converting each nibble into an ASCII equivalent representation, right aligning, and inserting a "_" after the 4th, 8th, 12th, 16th, 20th, 24th, 28th position, and a "." after the 32nd position in the string. The first hexadecimal digit shall be the most significant four bits of the first byte (i.e., most significant byte) of the NGUID field. For example, 0x0123456789ABCDEF0123456789ABCDEF would be converted to "0123_4567_89AB_CDEF_0123_4567_89AB_CDEF."

#### 6.1.3.1.2 EUI64-based Translation

**PAGE LENGTH** shall be set to 20 indicating the page length in bytes.
**PRODUCT SERIAL NUMBER** shall be set to a 20 byte value by translating the IEEE Extended Unique Identifier (EUI64) field of the Identify Namespace Data Structure.  The EUI64 field shall be translated by converting each nibble into an ASCII equivalent representation, right aligning, and inserting a "_" after

the 4th, 8th, 12th position, and a "." after the 16th position in the string. For example, 0x0123456789ABCDEF would be converted to "0123_4567_89AB_CDEF."

### 6.1.3.1.3 **V1.0-compliant Devices**

**PAGE LENGTH** should be set to 30 indicating the page length in bytes.
**PRODUCT SERIAL NUMBER** should be formed as follows:

- Bits 239:80  20 bytes of Serial Number (bytes 23:04 of Identify Controller data structure)
- Bits  79:72   ASCII representation of "_"
- Bits  71:08    ASCII representation of 32 bit Namespace Identifier (NSID)
- Bits  07:00   ASCII representation of "."

The Namespace Identifier field shall be translated by converting each hexadecimal nibble into an ASCII equivalent representation and right aligning.  For example, NSID 0x68430102 on a Controller with Serial Number "0123456789ABCDEF0123" would be converted to "0123456789ABCDEF_68430102."

## 6.1.4  **Device Identification Data Page**

Table 6-4:  Translation of Device Identification VPD Page

| Device Identification VPD Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating device for PERIPHERAL DEVICE TYPE connected to logical unit |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device |
| PAGE CODE | Shall be set to 83h indicating Device Identification VPD Page |
| PAGE LENGTH | Shall be set to the size of the remaining bytes of Device Identification VPD Page. |
| Designation Descriptor List | The designation descriptor list shall contain at least one designator in NAA IEEE Registered Extended designator format (refer to 6.1.4.1), T10 Vendor ID based designator format (refer to 6.1.4.3), SCSI Name String designator format (refer to 6.1.4.4) or EUI-64 designator format (refer to 6.1.4.5).<br><br>It is strongly recommended that the designator descriptor list contain at least one designator in the EUI-64 designator format (refer to 6.1.4.5). |

### 6.1.4.1 NAA IEEE Registered Extended designator format

Table 6-5: NAA Designation Descriptor

| NAA IEEE Registered Extended Designator Format Fields | Notes and References |
|---|---|
| PROTOCOL IDENTIFIER | Shall be set to 0h. PIV field shall indicate this field is reserved as no specific protocol to be identified. |
| CODE SET | Shall be set to 1h indicating associated fields are in binary format. |
| PIV | Shall be set to 0b indicating PROTOCOL IDENTIFIER field is reserved. |
| ASSOCIATION | Shall be set to 00b indicating DESIGNATOR field is associated with logical unit. |
| DESIGNATOR TYPE | Shall be set to 3h indicating NAA format and assignment authority. |
| DESIGNATOR LENGTH | Shall be set to the number of bytes of the DESIGNATOR field. |
| NAA | Shall be set to 6h indicating IEEE Registered NAA Extended. |
| IEEE COMPANY_ID | Shall be set using IEEE OUI Identifier field of the Identify Controller Data Structure (Note: refer to ECN 008). |
| VENDOR SPECIFIC IDENTIFIER<br><br>VENDOR SPECIFIC IDENTIFIER EXTENSION | VENDOR SPECIFIC IDENTIFIER and VENDOR SPECIFIC IDENTIFIER EXTENSION shall logically be combined to form a single 100-bit field.<br><br>NVMe devices in which the EUI64 bit field in the Identify Namespace data structure contains a non-zero value shall form the 100-bit field by concatenating the EUI64 (64 bits) field followed by "0x000000000" (36 bits).<br><br>For example, "0x0123456789ABCDEF" would be converted to "0x0123456789ABCDEF000000000".<br><br>NVMe devices compliant with revision 1.0 that do not support the EUI64 field shall form the 100-bit field as:<br>• Bits 99:84: 16 bit PCI Vendor ID (bytes 01:00 of Identify Controller data structure)<br>• Bits 83:32: Lower 52 bits of Serial Number (bytes 10:04 of Identify Controller data structure)<br>• Bits 31:00: Namespace Identifier |

| | |
|---|---|
| | NVMe devices in which the EUI64 bit field is cleared to zero are not supported by this designator format. |

### 6.1.4.2  NAA Locally Assigned Designator Format

**Table 6-6:  Translation of NAA Locally Assigned Designator**

| NAA Locally Assigned Designator Format Fields | Notes and References |
|---|---|
| PROTOCOL IDENTIFIER | Shall be set to 0h.  PIV field shall indicate this field is reserved as no specific protocol to be identified. |
| CODE SET | Shall be set to 1h indicating associated fields are in binary format. |
| PIV | Shall be set to 0b indicating PROTOCOL IDENTIFIER field is reserved. |
| ASSOCIATION | Shall be set to 00b indicating DESIGNATOR field is associated with logical unit. |
| DESIGNATOR TYPE | Shall be set to 3h indicating NAA format and assignment authority. |
| DESIGNATOR LENGTH | Shall be set to 08h indicating length of designator. |
| NAA | Shall be set to 3h indicating Locally Assigned Designator. |
| LOCALLY ADMINISTERED VALUE | For NVMe devices compliant with revision 1.1 or later, shall be set to the first 60 bits of the IEEE Extended Unique Identifier (EUI64) field of the Identify Namespace Data Structure.<br><br>For NVMe devices compliant with revision 1.0, shall be set to the concatenation of the translation of PRODUCT IDENTIFICATION field from standard INQUIRY data as specified in section 3.10, and the following 60-bit field:<br>• Bits 59:44: 16 bit PCI Vendor ID (bytes 01:00 of Identify Controller data structure)<br>• Bits 43:08: Lower 36 bits of Serial Number (bytes 08:04 of Identify Controller data structure)<br>• Bits 07:00: Lower 8 bits of Namespace Identifier |

### 6.1.4.3   T10 Vendor ID Based Descriptor

Table 6-7: T10 Vendor ID based Designation Descriptor

| T10 Vendor ID Based Descriptor Field | Notes and References |
|---|---|
| PROTOCOL IDENTIFIER | Shall be set to 0h.  PIV field shall indicate this field is reserved as no specific protocol to be identified. |
| CODE SET | Shall be set to 2h indicating associated fields are in ASCII format. |
| PIV | Shall be set to 0b indicating PROTOCOL IDENTIFIER field is reserved. |
| ASSOCIATION | Shall be set to 00b indicating DESIGNATOR field is associated with logical unit. |
| DESIGNATOR TYPE | Shall be set to 1h indicating T10 vendor ID based format. |
| DESIGNATOR LENGTH | Shall be set to size of T10 VENDOR IDENTIFICATION and VENDOR SPECIFIC IDENTIFIER fields. |
| T10 VENDOR IDENTIFICATION | Refer to 3.13. |
| VENDOR SPECIFIC IDENTIFIER | For NVMe devices compliant with revision 1.1 or later, shall be set to the concatenation of the translation of PRODUCT IDENTIFICATION field from standard INQUIRY data as specified in 3.10, followed by one of the following fields (containing a non-zero value):<br><br>• the IEEE Extended Unique Identifier (EUI64) field of the Identify Namespace Data Structure; or<br>• the NGUID field of the Identify Namespace Data Structure.<br><br>For NVMe devices compliant with revision 1.0, shall be set to the concatenation of the translation of PRODUCT IDENTIFICATION field from standard INQUIRY data as specified in 3.10, and the following 100-bit field:<br>• Bits 99:84: 16 bit PCI Vendor ID (bytes 01:00 of Identify Controller data structure)<br>• Bits 83:32: Lower 52 bits of Serial Number (bytes 10:04 of Identify Controller data structure)<br>• Bits 31:00: Namespace Identifier |

### 6.1.4.4 SCSI Name String Designator

| SCSI Name String Descriptor Field | Notes and References |
|---|---|
| PROTOCOL IDENTIFIER | Shall be set to 0h.  PIV field shall indicate this field is reserved as no specific protocol to be identified. |
| CODE SET | Shall be set to 3h indicating associated fields are in UTF-8 format. |
| PIV | Shall be set to 0b indicating PROTOCOL IDENTIFIER field is reserved. |
| ASSOCIATION | Shall be set to 00b indicating DESIGNATOR field is associated with logical unit. |
| DESIGNATOR TYPE | Shall be set to 8h indicating SCSI name string format and assignment authority. |
| DESIGNATOR LENGTH | Shall be set to size of SCSI NAME STRING field. |
| SCSI NAME STRING | See section 6.1.4.4.1. |

### 6.1.4.4.1 SCSI NAME STRING field

| NVMe EUI64 Field | NVMe NGUID Field | Notes and References |
|---|---|---|
| non-zero | zero | See section 6.1.4.4.1.2. |
| zero | non-zero | See section 6.1.4.4.1.1. |
| non-zero | non-zero | Section 6.1.4.4.1.1 or 6.1.4.4.1.2 shall be followed. Two separate descriptors, one based on each of the two sections above, may be returned. |
| non-zero | zero | See section 6.1.4.4.1.2. |
| zero | zero | See section 6.1.4.4.1.3. (Note: This case valid for NVMe 1.0 devices only.) |

#### 6.1.4.4.1.1 NGUID-based Translation

Shall  be set to a 36 byte UTF-8 character field  comprised of the four UTF-8 characters 'eui.' concatenated with UTF-8 representation of the 32 hexadecimal digits corresponding to the 128 bit NGUID field of the Identify Namespace Data Structure. The first hexadecimal digit shall be the most significant four bits of the first byte (i.e., most significant byte) of the NGUID field.

### 6.1.4.4.1.2    EUI64-based Translation

Shall  be set to a 20 byte UTF-8 character field comprised of the four UTF-8 characters 'eui.' concatenated with UTF-8 representation of the 16 hexadecimal digits corresponding to the 64 bit EUI64 field of the Identify Namespace Data Structure. The first hexadecimal digit shall be the most significant four bits of the first byte (i.e., most significant byte) of the EUI-64 field.

### 6.1.4.4.1.3    V1.0-compliant Devices

Shall be set to a 68 byte UTF-8 character field comprised of 4 bytes of UTF-8 representation of 2 byte PCI Vendor ID, plus 40 bytes of Model Number, plus 4 bytes of UTF-8 representation of Namespace ID, plus 20 bytes of Serial Number. Note: the start of the string (MSB) is at the lowest byte offset and the end of the string (LSB) is at the highest byte offset:
- Bytes 67:48: 20 bytes of Serial Number(bytes 23:04 of Identify Controller data structure)
- Bytes 47:44: 4 bytes of Namespace ID (UTF-8 representation)
- Bytes 43:04: 40 bytes of Model Number(bytes 63:24 of Identify Controller data structure)
- Bytes 03:00:  4 bytes of PCI Vendor ID (UTF-8 representation) (bytes 01:00 of Identify Controller converted to 4 UTF-8 characters

### 6.1.4.5    EUI-64 based Designator
Table 6-9: EUI-64 Designation Descriptor

| EUI64 Descriptor Field | Notes and References |
|---|---|
| PROTOCOL IDENTIFIER | Shall be set to 0h.  PIV field shall indicate this field is reserved as no specific protocol to be identified. |
| CODE SET | Shall be set to 1h indicating associated fields are in binary format. |
| PIV | Shall be set to 0b indicating PROTOCOL IDENTIFIER field is reserved. |
| ASSOCIATION | Shall be set to 00b indicating DESIGNATOR field is associated with logical unit. |
| DESIGNATOR TYPE | Shall be set to 2h indicating EUI-64 based identifier. |
| DESIGNATOR LENGTH | Shall be set to 08h if the EUI-64 field is populated from the NVMe **EUI64** field. Shall be set to 10h if the EUI-64 field is populated from the NVMe **NGUID** field. |
| EUI-64 Field | See section 6.1.4.5.1. |

### 6.1.4.5.1       **EUI-64 Field**

| NVMe EUI64 Field | NVMe NGUID Field | Notes and References |
|---|---|---|
| non-zero | zero | Shall contain the value of the NVMe **EUI64** field. |
| zero | non-zero | Shall contain the value of the NVMe **NGUID** field. |
| non-zero | non-zero | Shall contain the value of either the NVMe **EUI64** field or the NVMe **NGUID** field. Two separate descriptors, one based on each of the two fields above respectively, may be returned. |
| non-zero | zero | Shall contain the value of the NVMe **EUI64** field. |
| zero | zero | Not supported – the EUI-64 Designator descriptor format shall not be used. |

## 6.1.5   **Extended INQUIRY Data VPD Page**

This page is optional.

**Table 6-10:  Translation of Extended INQUIRY Data VPD Page**

| Extended INQUIRY Data Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating device for PERIPHERAL DEVICE TYPE connected to logical unit |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device |
| PAGE CODE | Shall be set to 86h indicating Extending INQUIRY Data VPD |
| PAGE LENGTH | Set to 3Ch |
| ACTIVATE MICROCODE | Shall be set to 10b indicating microcode will be activated after a hard reset. |
| SPT | SPT shall be translated using the DPC field of the Identify Namespace Data Structure:<br><br>DPC Value (bits 0-2) / SPT Value:<br>000b — Undefined<br>001b — 000b<br>010b — 010b<br>011b — 001b<br>100b — 100b<br>101b — 011b<br>110b — 101b<br>111b — 111b |
| GRD_CHK | If DPS field of Identify Namespace Data Structure is 000b, this field shall be set to 0b, otherwise set to 1b. |
| APP_CHK | If DPS field of Identify Namespace Data Structure is 000b, this field shall be set to 0b, otherwise set to 1b. |
| REF_CHK | If DPS field of Identify Namespace Data Structure is 000b, this field shall be set to 0b, otherwise set to 1b. |
| UASK_SUP | Shall be set to 1b indicating sense key specific data is returned for UNIT ATTENTION sense key. |
| GROUP_SUP | Shall be set to 0b indicating grouping function is unsupported. |
| PRIOR_SUP | Shall be set to 0b indicating command priority is unsupported. |
| HEADSUP | Shall be set to 0b indicating HEAD OF QUEUE task attribute is unsupported. |

The SPT field embedded table:

| DPC Value (bits 0-2) | SPT Value |
|---|---|
| 000b | Undefined |
| 001b | 000b |
| 010b | 010b |
| 011b | 001b |
| 100b | 100b |
| 101b | 011b |
| 110b | 101b |
| 111b | 111b |

| | |
|---|---|
| ORDSUP | Shall be set to 0b indicating ORDERED task attribute is unsupported. |
| SIMPSUP | Shall be set to 0b indicating SIMPLE task attribute is unsupported. |
| WU_SUP | Shall be set to 0b indicating WR_UNCOR field of WRITE LONG is unsupported if the NVMe Write Uncorrectable command is unsupported.<br><br>Shall be set to 1b indicating WR_UNCOR field of WRITE LONG is supported if the NVMe Write Uncorrectable command is supported. |
| CRD_SUP | Shall be set to 1b indicating COR_DIS field of WRITE LONG is supported if the NVMe Write Uncorrectable command is supported. Otherwise shall be set to 0b. |
| NV_SUP | Shall be set to 0b indicating a non-volatile cache is unsupported, i.e. FUA_NV is unsupported. |
| V_SUP | Shall be set using the Volatile Write Cache (VMC) field of the Identify Controller Data Structure. |
| P_I_I_SUP | Shall be set to 0b indicating protection information intervals are unsupported. |
| LUICLR | Shall be set to 1b indicating unit attentions are cleared according to SPC-4. |
| R_SUP | Shall be set to 0b indicating referrals are unsupported. |
| CBCS | Shall be set to 0b indicating capability-based command security is unsupported. |
| MULTI I_T NEXUS MICROCODE DOWNLOAD | Shall be set to 0h indicating handling of microcode downloads is vendor specific. |
| EXTENDED SELF-TEST COMPLETION MINUTES | Shall be set to 0h indicating that this field is unsupported. |
| POA_SUP | Shall be set to 0b indicating power on activation is unsupported. |
| HRA_SUP | Shall be set to 0b indicating hard reset activation is unsupported. |
| VSA_SUP | Shall be set to 0b indicating vendor specific activation is unsupported. |

| MAXIMUM SUPPORTED SENSE DATA LENGTH | Shall be set to 0h indicating that the device does not report a maximum sense data length. |
|---|---|

## 6.1.6 Block Limits VPD Page

**Table 6-11: Translation of Block Limits VPD Page**

| Block Limits VPD Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating device for PERIPHERAL DEVICE TYPE connected to logical unit |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device |
| PAGE CODE | Shall be set to B0h indicating Block Limits VPD Page |
| PAGE LENGTH | Shall be set to 003Ch. |
| WSNZ | Unspecified |
| MAXIMUM COMPARE AND WRITE LENGTH | Shall be set to 00h if Fused Operation is not supported; May be set to a non-zero value that is less than or equal to the value in MAXIMUM TRANSFER LENGTH field if Fused Operation is supported. |
| OPTIMAL TRANSFER LENGTH GRANULARITY | Unspecified |
| MAXIMUM TRANSFER LENGTH | Shall be set to value calculated according to method described in NVMe v1.1 Identify Controller Data Structure: Maximum Data Transfer Size (MDTS) |
| OPTIMAL TRANSFER LENGTH | Unspecified |
| MAXIMUM PREFETCH LENGTH | Unspecified |
| MAXIMUM UNMAP LBA COUNT | Shall be set to 0000_0000h if Dataset Management command – Deallocate (AD) attribute is not supported. Shall be set to non-zero value if Dataset Management command – Deallocate (AD) attribute is supported. |
| MAXIMUM UNMAP BLOCK DESCRIPTOR COUNT | Shall be set to 0000_0000h if Dataset Management command – Deallocate (AD) attribute is not supported. Shall be set to 0000_0100h if Dataset Management command – Deallocate (AD) attribute is supported. |
| OPTIMAL UNMAP GRANULARITY | Unspecified |
| UNMAP GRANULARITY ALIGNMENT | Unspecified |
| UGAVALID | Unspecified |

| MAXIMUM WRITE SAME LENGTH | Unspecified |
|---|---|

## 6.1.7  **Block Device Characteristics VPD Page**

**Table 6-12:  Translation of Block Device Characteristics VPD Page**

| Block Device Characteristics VPD Field | Notes and References |
|---|---|
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating device for PERIPHERAL DEVICE TYPE connected to logical unit |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device |
| PAGE CODE | Shall be set to B1h indicating Device Identification VPD Page |
| PAGE LENGTH | Shall be set to 3Ch. |
| MEDIUM ROTATION RATE | Shall be set to 0001h indicating a non-rotating device (SSD). |
| NOMINAL FORM FACTOR | Shall be set to 0h indicating form factor not reported. |

## 6.1.8  **Logical Block Provisioning VPD Page**

**Table 6-13:  Translation of Block Device Characteristics VPD Page**

| Block Limits VPD Field | Notes and References |
| --- | --- |
| PERIPHERAL QUALIFIER | Shall be set to 000b indicating device for PERIPHERAL DEVICE TYPE connected to logical unit |
| PERIPHERAL DEVICE TYPE | Shall be set to 00h indicating direct access block device |
| PAGE CODE | Shall be set to B2h indicating Block Limits VPD Page |
| PAGE LENGTH | Shall be set to 04h. |
| THRESHOLD EXPONENT | Shall be set to 00h to indicate that there are no thin provisioning thresholds<br><br>This would require modification if thin-provisioning is supported |
| LBPU | Shall be set to 0 if Dataset Management command – Deallocate (AD) attribute is not supported.<br><br>Shall be set to 1 if Dataset Management command – Deallocate (AD) attribute is supported. Shall be set to 1 if PROVISIONING TYPE is set to 1 or 2.<br><br>This is reporting whether use of UNMAP to unmap LBAs is supported. |
| LBPWS | Shall be set to 0, to indicate that use of WRITE SAME(16) to unmap LBAs is not supported. |
| LBPWS10 | Shall be set to 0, to indicate that use of WRITE SAME(10) to unmap LBAs is not supported. |
| LBPRZ | Shall be set to 1 if Dataset Management command – Deallocate (AD) attribute is supported and the device returns all zeros for reads of deallocated LBAs, otherwise set to 0. |

| | |
|---|---|
| ANC_SUP | Shall be set to 0, to indicate that setting the ANCHOR bit in UNMAP is not supported if the namespace is not resource or thin provisioned.<br><br>Shall be set to 1, to indicate that setting the ANCHOR bit in UNMAP is supported if the namespace is resource provisioned. May be set to 1 if the namespace is thin provisioned. |
| DP | Shall be set to 0, to indicate that no Provisioning Group Descriptors follow.<br><br>This would require modification if thin-provisioning is supported |
| PROVISIONING TYPE | Shall be set to 0 (Full) if Dataset Management command – Deallocate (AD) attribute is not supported  and Identify Namespace Data = NSFEAT bit 0 is reported "0" indicating that the namespace is not thin-provisioned.<br><br>Shall be set to 1(Resource) if Dataset Management command – Deallocate (AD) attribute is supported and Identify Namespace Data – NSFEAT bit 0 is reported "0",, indicating that the namespace is resource-provisioned.<br><br>Shall be set to 2(Thin) if Dataset Management command – Deallocate (AD) attribute is supported  and Identify Namespace Data – NSFEAT bit 0 is reported "1", indicating that the namespace is thin-provisioned. |

## 6.2 Log Pages

### 6.2.1 Supported Log Pages

**Table 6-14: Translation of Supported Log Pages**

| Supported Log Pages Log Page Field | Notes and References | | |
|---|---|---|---|
| PAGE CODE | Set to 00h as specified in SPC-4. | | |
| SPF | Set to 0b as specified in SPC-4. | | |
| DS | Set to 0b as specified in SPC-4. | | |
| SUBPAGE CODE | Set to 00h as specified in SPC-4. | | |
| PAGE LENGTH | Shall be set to 03h or 04h indicating the length of Supported Pages List. | | |
| Supported Pages List | **PAGE CODE** | **Notes** | |
| | 00h | Indicates support for Supported Log Pages log page. (Mandatory) | |
| | 0Dh | Indicates support for Temperature Log Page log page. (Mandatory) | |
| | 11h | Indicates support for Solid State Media log page. (Optional) | |
| | 2Fh | Indicates support for Informational Exceptions log page. (Mandatory) | |

### 6.2.2 Temperature Log Page

**Table 6-15: Translation of Temperature Log Page**

| Temperature Log Page Field | Notes and References |
|---|---|
| DS | Unspecified. |
| SPF | Shall be set to 0b as specified in SPC-4. |
| PAGE CODE | Shall be set to 0Dh as specified in SPC-4. |
| SUBPAGE CODE | Shall be set to 00h as specified by SPC-4. |
| PAGE LENGTH | Shall be set to 0Ch as specified by SPC-4. |
| PARAMETER CODE | Shall be set to 0000h as specified in SPC-4. |
| FORMAT AND LINKING | Shall be set to 11b indicating parameter is in binary format. |
| TMC | Shall be set to 00b for LOG SENSE as specified by SPC-4 or ignored. |
| ETC | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| TSD | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| DU | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| PARAMETER LENGTH | Shall be set to 02h as specified in SPC-4. |

| TEMPERATURE | Shall be set to Temperature field of Get Log Page – SMART / Health Information Log.  This shall require a conversion from Kelvin to Celsius. |
|---|---|
| PARAMETER CODE | Shall be set to 0001h as specified in SPC-4. |
| FORMAT AND LINKING | Shall be set to 11b indicating parameter is in binary format. |
| TMC | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| ETC | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| TSD | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| DU | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| PARAMETER LENGTH | Shall be set to 02h as specified in SPC-4. |
| REFERENCE TEMPERATURE | Shall be set using Temperature Threshold Feature of Get Features command.  This shall require a conversion from Kelvin to Celsius |

### 6.2.3   Solid State Media Log Page

Table 6-16: Translation of Solid State Media Log Page

| Temperature Log Page Field | Notes and References |
|---|---|
| DS | Unspecified. |
| SPF | Shall be set to 0b as specified in SPC-4. |
| PAGE CODE | Shall be set to 11h as specified in SPB-3. |
| SUBPAGE CODE | Shall be set to 00h as specified by SPB-3. |
| PAGE LENGTH | Should be set to 08h as specified by SPB-3. |
| PARAMETER CODE | Shall be set to 0001h as specified in SPB-3. |
| FORMAT AND LINKING | Shall be set to 11b indicating parameter is in binary format. |
| TMC | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| ETC | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| TSD | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| DU | Shall be set to 0 for LOG SENSE as specified by SPC-4 or ignored. |
| PARAMETER LENGTH | Shall be set to 04h as specified in SBC-3. |
| PERCENTAGE USED ENDURANCE INDICATOR | 1. Issue Get Features command to retrieve the SMART / Health Information Log.<br>2. Set the PERCENTAGE USED ENDURANCE INDICATOR field in the Solid State Media log page from the Percentage Used field in the Get Features result. |

## 6.2.4 **Information Exceptions Log Page**

Table 6-17: Translation of Informational Exceptions Log Page

| Informational Exceptions Log Page Field | Notes and References |
|---|---|
| PAGE CODE | Set to 2Fh as specified in SPC-4. |
| SPF | Set to 0b as specified in SPC-4. |
| DS | Set to 0b as specified in SPC-4. |
| SUBPAGE CODE | Set to 00h as specified in SPC-4. |
| PAGE LENGTH | Shall be set to 8h indicating the length of remaining log page. |
| PARAMETER CODE | Set to 0000h as specified by SPC-4. |
| FORMAT AND LINKING | Shall be set to 11b indicating parameter is a binary format list parameter. |
| TMC | Set to 00b as specified in SPC-4. |
| ETC | Set to 0b as specified in SPC-4. |
| TSD | Set to 1b indicating log parameter disabled. |
| DU | Set to 0b as specified in SPC-4. |
| PARAMETER LENGTH | Shall be set to 04h indicating 4 parameters. |
| INFORMATIONAL EXCEPTION ADDITIONAL SENSE CODE | Shall be set to 0h. |
| INFORMATIONAL EXCEPTION ADDITIONAL SENSE CODE QUALIFIER | Shall be set to 0h. |
| MOST RECENT TEMPERATURE READING | Shall be supported using Temperature field of Get Log Page SMART / Health Information Log.  A conversion to Celsius from Kelvin must occur. |

## 6.3 **Mode Parameters**

Mode Parameters specify information regarding a logical unit. MODE SELECT is used by application clients to set parameter values. MODE SENSE is used to return current values of parameter data to application client. An NVM Express driver may support a mode parameter by mapping the value to an NVM Express data structure if possible or by storing the parameter value internally within the driver. There is no distinction between current and saved mode pages. The mode parameter list contains a mode parameter header, zero or more block descriptors, followed by zero or more variable-length mode pages.

### 6.3.1 **Mode Parameter Headers**

Mode Parameter Header(6) is used by MODE SELECT(6) and MODE SENSE(6) commands. Mode Parameter Header(10) is used by MODE SELECT(10) and MODE SENSE(10). Mode Parameter Header(6) and Mode Parameter Header(10) have similar fields and are translated in Table 6-18. When not specified in the description, each field is applicable to both MODE SENSE and MODE SELECT commands.

**Table 6-18: Mode Parameter Header Field Translations**

| Mode Parameter Header Field | Notes and References |
|---|---|
| MODE DATA LENGTH | Shall indicate number of bytes of data to transfer. The mode data length does not include the number of bytes in the MODE DATA LENGTH field. When translating MODE SELECT commands, this field is reserved. |
| MEDIUM TYPE | Shall be set to 00h indicating a direct access block device. |
| WP | Shall be set to 1b if bit 3 of the Critical Warning field of the SMART / Health Information Log page is set to 1b (i.e. media has been placed in read only mode.). Otherwise shall be set to 0b. |
| DPOFUA | When used with MODE SELECT this field is reserved. Shall be set to 1b indicating DPO and FUA are supported. |
| LONGLBA* | This field shall be ignored for MODE SELECT 10. <table><tr><th>LONGLBA</th><th>Notes</th></tr><tr><td>0b</td><td>Shall be set to 0b indicating mode parameter block descriptors are 8 bytes long should there be any.</td></tr><tr><td>1b</td><td>Shall be set to 1b indicating mode parameter block descriptor(s) are 16 bytes long should there be any.</td></tr></table> |
| BLOCK DESCRIPTOR LENGTH | The value of this field is determined by the LONGLBA field and shall indicate the number of bytes of all block descriptors: <table><tr><th>LONGLBA</th><th>Notes</th></tr><tr><td>0b</td><td>Shall indicate the number if block descriptors multiplied by 8.</td></tr></table> |

| | 1b | Shall indicate the number if block descriptors multiplied by 16. |
|---|---|---|
| | | Note that this length does not include mode pages that may follow the last block descriptor should there be any. |
| * Mode Parameter Header 10 only. | | |

## 6.3.2 Mode Parameter Block Descriptor

Mode Parameter Block Descriptors may be optionally supported and are used to specify the size and number of blocks of a logical unit. Table 6-19 describes how to determine the initial values of the parameters.   Support for this parameter when used along with a FORMAT UNIT command requires retention of the fields within the driver during a MODE SELECT command.

**Table 6-19:** Mode Parameter Block Descriptor Field Translations

| Mode Parameter Block Descriptor Field | Notes and References |
|---|---|
| NUMBER OF LOGICAL BLOCKS | Shall be determined through translation of Namespace Capacity of Identify Namespace Data Structure. |
| LOGICAL BLOCK LENGTH | Shall be determined through translation of Formatted LBA Size (FLBAS) field of Identify Namespace Data Structure. |

## 6.3.3 Mode Page Formats

The following sections define the translation for the supported mode pages.

## 6.3.3.1    Read-Write Error Recovery Mode Page

Table 6-20:  Read-Write Error Recovery Mode Page Field Translations

| Read-Write Recovery Mode Page Field | Notes and References |
|---|---|
| PS | Shall be set to 0b indicating device server is unable to save parameters. |
| SPF | Shall be set to 0b indicating page 0 mode page format is being used |
| PAGE CODE | Shall be set to 01h indicating Read-Write Error Recovery Mode Page. |
| PAGE LENGTH | Shall be set to 0Ah indicating number of bytes of mode parameters. |
| DCR | Shall be set to 0b indicating the use of additional information (e.g., ECC bytes) for data error recovery is allowed. |
| DTE | Shall be set to 0b indicating that upon detection of a recovered error, the device shall not terminate the data transfer to the Data-In Buffer for a read command or the data transfer to the Data-Out Buffer for a write command. |
| PER | Shall be set to 0b |
| EER | Unspecified. |
| RC | Shall be set to 0b, indicating that error recovery operations that cause delays during the data transfer are acceptable; data shall not be fabricated. |
| TB | Unspecified. |
| ARRE | Shall be set to 1b, indicating that the device shall enable automatic read reassignment for LBAs referencing logical blocks for which a recovered error occurs during a read medium operation. |
| AWRE | Shall be set to 1b, indicating that the device shall enable automatic write reassignment for LBAs referencing logical blocks for which a recovered or unrecovered error occurs during a write medium operation. |
| READ RETRY COUNT | Unspecified. |

| WRITE RETRY COUNT | Unspecified. |
|---|---|
| RECOVERY TIME LIMIT | The value of this field is dependent on the command:<br><br><table><tr><td>MODE SENSE</td><td>Shall be set to the value of the Time Limited Error Recovery field of the NVM Express Get Features command with Error Recovery Identifier.</td></tr><tr><td>MODE SELECT</td><td>The value of the Time Limited Error Recovery field of the NVMe Set Features Cmd with Error Recovery Feature Identifier shall be set to this nearest rounded-up 100 millisecond value.</td></tr></table><br>The value shall be converted to 100 millisecond units when sending to the device (MODE SELECT) and the value shall be converted to 1 millisecond units when receiving from the device (MODE SENSE). |

### 6.3.3.2 Caching Mode Page

| Caching Mode Page Field | Notes and References |
|---|---|
| Write Back Cache Enable (WCE) | The value of this field is dependent on the command:<br><table><tr><td>MODE SENSE</td><td>Shall be set to the value of Volatile Write Cache Enable field of the NVM Express Get Features command with Volatile Write Cache Feature Identifier.</td></tr><tr><td>MODE SELECT</td><td>Shall be set to the value of Volatile Write Cache Enable field of the NVM Express Set Features command with the Volatile Write Cache Feature Identifier to be sent to the NVMe device.</td></tr></table> |
| All other fields shall be unspecified. |  |

### 6.3.3.3 Control Mode Page

Table 6-22: Control Mode Page Field Translations

| Control Mode Page Field | Notes and References |
|---|---|
| PS | Shall be set to 0b indicating device server is unable to save parameters. |
| SPF | Shall be set to 0b indicating page_0 mode page format is being used. |
| PAGE CODE | Shall be set to 0Ah indicating Control Mode Page. |
| PAGE LENGTH | Shall be set to 0Ah indicating number of bytes of mode parameters. |
| TST | Shall be set to 000b indicating one task set for all I_T nexuses. |
| TMF_ONLY | Shall be set to 0b.  Note that ACA is not supported. |
| DPICZ | Shall be set to 0b to indicate that checking of protection information bytes is enabled. Otherwise shall be set to 1b to indicate that checking of protection information is disabled on commands with the RDPROTECT, VRPROTECT or ORPROTECT field set to zero. |
| D_SENSE | Shall be set to 1b indicating that sense data is returned in descriptor format. |
| GLTSD | Shall be set to 1b indicating that the logical unit does not implicitly save log parameters. |
| RLEC | Shall be set to zero indicating log exception conditions are not reported. |
| QUEUE ALGORITHM MODIFIER | Shall be set to one indicating commands may be reordered. |
| NUAR | Shall be set to 0b.  Note that reservations are not supported. |
| QERR | Shall be set to 01b. |
| RAC | Shall be set to 0b indicating the device server may return BUSY status for any length of time while BUSY condition persists. |

| UA_INTLCK_CTRL | Shall be set to 00b indicating that unit attention condition is cleared in the same transaction as a CHECK CONDITION status. |
|---|---|
| SWP | Shall be set to 0b indicating no support for software write protect. |
| ATO | Shall be set to 1b indicating that:<br><br>a) the LOGICAL BLOCK APPLICATION TAG shall not be modified when the NVMe namespace is formatted with any type of protection information; and<br>b) the LOGICAL BLOCK REFERENCE TAG shall not be modified when the NVMe namespace is formatted with type 3 protection information. |
| TAS | Shall be set to one indicating that aborted commands shall be completed with TASK ABORTED status. |
| AUTOLOAD MODE | Shall be set to 000b indicating medium is loaded for full access when inserted. |
| BUSY TIMEOUT PERIOD | Shall be set to FFFFh indicating unlimited busy timeout. |
| EXTENDED SELF-TEST COMPLETION TIME | Shall be set to 0000h, SMART self-tests are unsupported. |

### 6.3.3.4 Power Condition Control Mode Page

**Table 6-23: Translation of Power Condition Control Mode Page**

| Power Condition Control Mode Page Field | Notes and References |
|---|---|
| PS | Shall be set to 0h indicating page not savable. |
| SPF | Shall be set to 0h indicating page_0 page format is used. |
| PAGE CODE | Set to 1Ah as specified by SPC-4. |
| PAGE LENGTH | Set to 26h as specified by SPC-4. Indicates length of page. |
| PM_BG_PRECENDENCE | Shall be set to 00H, indicating vender specific power management and background interactions. |
| STANDBY_Y | Timers are not supported in NVM Express. When processing a MODE SENSE command, these fields shall be returned as zero. When processing a MODE SELECT command, the command may be terminated with CHECK CONDITION status, sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN PARAMETER LIST. |
| IDLE_C | |
| IDLE_B | |
| IDLE_A | |
| STANDBY_Z | |
| IDLE_A CONDITION TIMER | |
| STANDBY_Z CONDITION TIMER | |
| IDLE_B CONDITION TIMER | |
| IDLE_C CONDITION TIMER | |
| STANDBY_Y CONDITION TIMER | |

### 6.3.3.5    Return all pages Mode Page

Table 6-24:  Mode pages returned

| Mode Pages (returned in ascending numerical order) |
|---|
| 0x01 |
| 0x08 |
| 0x0A |
| 0x1A |
| 0x1C |

### 6.3.3.6    Return all pages and subpages Mode Page

Table 6-25: Mode pages returned

| Mode Pages (returned in ascending numerical order) | SubPage |
|---|---|
| 0x01 | 0x00 |
| 0x08 | 0x00 |
| 0x0A | 0x00 |
| 0x1A | 0x00 |
| 0x1C | 0x00 |

### 6.3.3.7 Informational Exceptions Control Mode Page

Table 6-26: Translation of Informational Exceptions Control Mode Page

| Informational Exceptions Control Mode Page Field | Notes and References |
|---|---|
| PS | Shall be set to 0b indicating page not savable. |
| SPF | Shall be set to 0b indicating page_0 mode page format is used. |
| PAGE CODE | Set to 1Ch as specified by SPC-4. |
| PAGE LENGTH | Shall be set to 0Ah indicating length of page. |
| LOGERR | Shall be set to 0b indicating device server may log informational exception conditions in the Informational Exceptions log page. |
| EBACKERR | Shall be set to 0b indicating reporting of informational exception conditions occurring during processing of background self tests is disabled. |
| TEST | |
| DEXPT | <table><tr><td>Field</td><td>Value</td><td>Comments</td></tr><tr><td>TEST</td><td>0</td><td rowspan="3">Failure prediction processing and warning processing shall be disabled.</td></tr><tr><td>DEXCPT</td><td>1</td></tr><tr><td>EWASC</td><td>0</td></tr></table> |
| EWASC | |
| EBF | Shall be set to 0b indicating device specific background functions are disabled. |
| PERF | Shall be set to 1b indicating processing of informational exception conditions that cause delays are disabled. |
| MRIE | Shall be set to 0h indicating device server shall not report informational exception conditions. |
| INTERVAL TIMER | Shall be set to zero indicating reporting informational exception conditions are vendor specific. |
| REPORT COUNT | Shall be set to zero indicating no limit on number of times a device server may report informational exception conditions. |

## 6.4 READ CAPACITY Parameter Data

READ CAPACITY Parameter Data is returned to application client in response to a READ CAPACITY(10) or READ CAPACITY(16) command (refer to 5.4).

**Table 6-27: Translation of READ CAPACITY Parameter Data**

| READ CAPACITY Parameter Data Field | Notes and References | |
|---|---|---|
| RETURNED LOGICAL BLOCK ADDRESS | Shall be set to: | |
| | READ CAPACITY (10) | Shall be set to Namespace Size NSZE field of the Identify Namespace Data Structure, or FFFF_FFFFh if NSZE exceeds the maximum value this field is able to contain. Note that if this field is set to FFFF_FFFFh then SBC-3 specifies that the application client issue a READ CAPACITY (16). |
| | READ CAPACITY(16) | Shall be set to Namespace Size NSZE field of the Identify Namespace Data Structure, or FFFF_FFFF_FFFF_FFFFh if NSZE exceeds the maximum value this field is able to contain. |
| LOGICAL BLOCK LENGTH | Shall be set to the LBA Data Size (LBADS) field of the LBA Format Data Structure currently indicated by the Formatted LBA Size (FLBAS) field within the Identify Namespace Data Structure. | |
| PROT_EN* | Shall be set to 0b if protection information is not enabled as indicated in the End-to-end Protection Type Settings (DPS) field within Identify Namespace Data Structure. Otherwise shall be set to 1b. | |
| P_TYPE* | Shall be set using End to End Data Protection Type Settings field of Identify Namespace Data Structure: | |

| DPS Code | P_TYPE Code |
|---|---|
| 000b | Unspecified |
| 001b | 000b |
| 010b | 001b |
| 011b | 010b |

| | | |
|---|---|---|
| LOGICAL BLOCKS PER PHYSICAL EXPONENT* | Shall be set to 0 indicating one or more physical blocks per logical block. | |
| P_I_EXPONENT* | Unspecified. Indicates number of protection information intervals within each logical block. | |
| TPE* | Unspecified. Indicates thin provisioning is implemented. | |
| TPRZ* | Unspecified. Indicates how unmapped LBA bits should be set. | |
| LOWEST ALIGNED LOGICAL BLOCK ADDRESS* | Shall be set to zero indicating LBA 0 is the first logical blocks located at the beginning of a physical block. | |
| *READ CAPACITY (16) parameter data only | | |

## 6.5 Sense Data

Sense data is requested by the application client with a REQUEST SENSE command. Since autosense is supported, sense information is returned along with the completion of a command to the application client.

### 6.5.1 Fixed Format Sense Data

| Fixed Format Sense Data Field | Notes and References |
|---|---|
| RESPONSE CODE | Shall be set to 70h indicating current errors are returned. |
| VALID | Shall be set to 0b indicating INFORMATION field is not defined. |
| SENSE KEY | Shall be set to NO SENSE. |
| ILI | Shall be set to 0b, field is undefined. |
| EOM | Shall be set to 0b, field is undefined. |
| FILEMARK | Shall be set to 0b, field is undefined. |
| INFORMATION | Shall be set to 0b, field is undefined. |
| ADDITIONAL SENSE LENGTH | Shall indicate the number of bytes of additional sense data. |
| COMMAND-SPECIFIC INFORMATION | Shall contain information depending on command where the exception condition occurred. |
| ADDITIONAL SENSE CODE | Shall be set to NO ADDITIONAL SENSE INFORMATION if device is in power state 00h, otherwise shall be set to LOW POWER CONDITION ON. |
| ADDITIONAL SENSE CODE QUALIFIER | Shall be set to zero indicating detailed information is not available. |
| FIELD REPLACEABLE UNIT CODE | Shall be set to zero indicating no additional sense code. |
| SENSE KEY SPECIFIC | Shall be set to zero, field is undefined. |
| SKSV | Shall be set to zero indicating SENSE KEY SPECIFIC field is undefined. |

### 6.5.2 Descriptor Format Sense Data

Table 6-28: Descriptor Format Sense Data Field Translations

| Fixed Format Sense Data Field | Notes and References |
|---|---|
| RESPONSE CODE | Shall be set to 72h indicating current errors are returned. |
| SENSE KEY | Shall be set to NO SENSE. |
| ADDITIONAL SENSE CODE | Shall be set to NO ADDITIONAL SENSE INFORMATION if device is in power state 00h, otherwise shall be set to LOW POWER CONDITION ON. |
| ADDITIONAL SENSE CODE QUALIFIER | Shall be set to zero indicating detailed information is not available. |
| ADDITIONAL SENSE CODE LENGTH | Shall be set to zero indicating no additional sense code. |

## 6.6 REPORT LUNS Parameter Data

REPORT LUNS Parameter data is requested by the application client with a REPORT LUNS command (refer to 4.5).  Support for REPORT LUNS requires the Identify command.

**Table 6-29:  REPORT LUNS Parameter Data Field Translations**

| REPORT LUNS Parameter Data Field | Notes and References |
|---|---|
| LUN LIST LENGTH | Shall indicate the length of the LUN LIST as specified in SPC-4. The LUN LIST LENGTH depends on the translation of the LUN LIST field. |
| LUN LIST | The list shall contain logical unit numbers corresponding to namespaces present on the device with a Namespace Capacity (NCAP) field of the Identify Namespace Structure set to greater than 0h.  Logical unit numbers shall begin with 0 and have a maximum value of NN-1, where NN is the Number of Namespaces field within Identify Controller Data Structure. |

## 6.7 PERSISTENT RESERVE IN/OUT Parameter Data

Many translations require the SNTL send NVM Reservation Report command, which requires a buffer allocated to transfer the report, and report that buffer's size in DWORDs. The minimum size in DWORDs the host should have allocated for the Reservation Status buffer is 12, with 6 additional for every registered controller in the NVMe subsystem. The NVMe Reservation Status data structure's REGCTL can be used to calculate how many DWORDS should have been allocated if the buffer in the original request was not large enough.

### 6.7.1 PERSISTENT RESERVE IN Parameter Data for READ KEYS

The SNTL shall support this SCSI command by issuing NVM Reservation Report (0Eh) command with the NSID set for the namespace being queried with command DWORD 10 (NUMD) set to the 0's based size of the Reservation Status structure, and then translating from the following table.

**Table 6-30: READ KEYS**

| READ KEYS Field | Notes and References |
|---|---|
| PRGENERATION | Shall be set to Reservation Status Data Structure GEN field, returned from Reservation Report command. |
| ADDITIONAL LENGTH | Shall be set to the number of additional bytes that follow, which is the number of registered keys (Reservation Status Data Structure REGCTL field) times the size of each key (8 bytes). |
| RESERVATION KEY [first] | Shall be set to Reservation Status Data Structure RKEY field from the first controller returned from Reservation Report command. |
| … |  |

| | Shall be set to Reservation Status Data Structure RKEY field from the last controller returned from Reservation Report command. |
|---|---|
| RESERVATION KEY [last] | |

## 6.7.2  PERSISTENT RESERVE IN Parameter Data for READ RESERVATIONS

The SNTL shall support this SCSI command by issuing NVM Reservation Report (0Eh) command with NSID set to the namespace being queried and command DWORD 10 (NUMD) set to the 0's based size of the buffer used for the Reservation Status structure, and then translating from the following table.

Table 6-31: READ RESERVATIONS

| READ RESERVATIONS Field | Notes and References |
|---|---|
| PRGENERATION | Shall be set to Reservation Status Data Structure GEN field, returned from Reservation Report command. |
| ADDITIONAL LENGTH | Shall be set to Reservation Status Data Structure 10h, or 00h if no reservation is held (SPC-4). |
| RESERVATION KEY | Shall be set to Reservation Status Data Structure RKEY field from the controller holding the reservation from Reservation Report command. |
| SCOPE | Shall be set to 0h (SPC-4). |
| TYPE | Shall be translated from Reservation Status RTYPE field. See Table 4-14. |

## 6.7.3  PERSISTENT RESERVE IN Parameter Data for READ CAPABILITIES

The SNTL shall support this SCSI command by issuing NVMe Identify (06h) command with CNS set to 0 for Identify Namespace and NSID set to the namespace being queried. The SNTL shall also issue Get Features (09h) with FID set to Reservation Persistence 83h. Once both commands are completed, the translation is done as defined in the following table.

Table 6-32: READ CAPABILITIES

| READ CAPABILITIES Field | Notes and References |
|---|---|
| LENGTH | Set to 0008h (SPC-4) |
| CRH | Compatible Reservation Handling shall set to 0b as SPC-2 RESERVE commands won't be handled at all and shall be terminated with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID OPCODE additional sense. |
| SIP_C | Specify Initiation Ports Capability shall be set to 0b as there is not NVMe parameter to specify a specific host. |

| | |
|---|---|
| ATP_C | All Target Port Capability shall be set to 1b as the NVMe subsystem applies registration to all controllers with matching the host identifier (HOSTID). |
| PTPL_C | Persistent through Power Loss Capability shall be set to bit 0 from Identify Namespace's RESCAP field. |
| PTL_A | Persistent Through Power Loss Activated shall be set to Get Feature "Reservation Persistence" (Feature Identifier 83h) PTPL value from the Command Completion's command specific status field. |
| ALLOWED COMMANDS | Shall be set to 000b, making no guarantees on allowed commands. |
| TMV | Type Mask Valid shall be set 1 to indicate the reservation type mask is valid. |
| PERSISTENT RESERVATION TYPE MASK | From Identify Namespace, translate the returned value in RESCAP field as defined in the following table: <br><br> **Type** / **Notes** <br> WR_EX — Shall be set if RESCAP bit 1 is set. <br> EX_AC — Shall be set is RESCAP bit 2 is set. <br> WR_EX_RO — Shall be set if RESCAP bit 3 is set. <br> EX_AC_RO — Shall be set if RESCAP bit 4 is set. <br> WR_EX_AR — Shall be set if RESCAP bit 5 is set. <br> EX_AC_AR — Shall be set if RESCAP bit 6 is set. |

### 6.7.4  PERSISTENT RESERVE IN Parameter Data for READ FULL STATUS

The SNTL shall support this SCSI command by issuing NVM Reservation Report (09h) command with NSID set to the namespace being queried and command DWORD 10 (NUMD) set to the 0's based size of the reservation Status structure, and then translating in the following table.

Table 6-33: READ FULL STATUS

| READ FULL STATUS Field | Notes and References |
|---|---|
| PRGENERATION | Shall be set to Reservation Status Data Structure GEN field, returned from Reservation Report command. |

| | Shall be set to the number of bytes that follow, which is the number of registered keys (Reservation Status Data Structure REGCTL field) times the size of each descriptor (32 bytes, defined in Table 6-34). |
| --- | --- |
| ADDITIONAL LENGTH | |
| FULL STATUS DESCRIPTOR [first] | Shall be set from Reservation Status Data Structure field from the first controller returned from Reservation Report command (Table 6-34). |
| … | |
| FULL STATUS DESCRIPTOR [last] | Shall be set from Reservation Status Data Structure field from the last controller returned from Reservation Report command (Table 6-34). |

Table 6-34: FULL STATUS DESCRIPTOR

| FULL STATUS DESCRIPTOR Field | Notes and References |
| --- | --- |
| RESERVATION KEY | Shall be set to this entry's RKEY value from NVME Reservation Report Registered Controller Data Structure. |
| R_HOLDER | Shall be set to 1b if this entry's NVME Reservation Report Registered Controller Data Structure RCSTS field bit 1 is set, and 0b otherwise. |
| ALL_TG_PT | Shall be set to 1b. |
| SCOPE | Shall be set to 00h. |
| TYPE | Set from this entry's RTYPE value. See Table 4-14. |
| RELATIVE TARGET PORT ID | Shall be set to this entry's CNTLID from NVME Reservation Report Registered Controller Data Structure. |
| ADDITIONAL DESCRIPTOR LENGTH | Shall be set to 08h to account for the Transport ID. |
| TRANSPORT ID | Shall be set to this entry's HOSTID from NVMe Reservation Report Registered Controller Data Structure. |

## 6.7.5   PERSISTENT RESERVE OUT Parameter List

The SNTL shall support this SCSI command by issuing NVM Reservation Acquire (11h), Register (0Dh), or Release (15h) command depending on the service action. The specific command to issue depends on the

SCSI command's Service Action from CDB (see 4.13.2 for details), and translation to each action and parameter list fields are defined in the following table.

Table 6-35: PERSISTENT RESERVE OUT

| PARAMETER LIST | Notes and References |
|---|---|
| RESERVATION KEY | <table><tr><td>**Service Action**</td><td>**Notes**</td></tr><tr><td>REGISTER AND MOVE</td><td>The SNTL shall set the Reservation Register Data Structure CRKEY to the parameter list RESERVATION KEY.<br><br>Reservation Register command's DWORD 10 RREGA field shall be set to 010b (Replace).</td></tr><tr><td>RESERVE/PREEMPT/ PREEMPT AND ABORT</td><td>The SNTL shall set the Reservation Acquire Data Structure CRKEY to the parameter list RESERVATION KEY.</td></tr><tr><td>RELEASE/CLEAR</td><td>The SNTL shall set the Reservation Release Data Structure CRKEY to the parameter list RESERVATION KEY.</td></tr><tr><td>REGISTER/REGISTER AND IGNORE EXISITING KEY</td><td>If SERVICE ACTION RESERVATION KEY is zero, the SNTL shall set the Reservation Register Data Structure CRKEY to parameter list RESERVATION KEY, and shall set Reservation Register command's DWORD 10 RREGA field 001b (Unregister).<br><br>If SERVICE ACTION RESERVATION KEY is non-zero, this parameter field shall be ignored, the SNTL shall treat the Reservation Register Data Structure CRKEY as reserved, and shall set Reservation Register command's DWORD 10 RREGA field to 000b (Register).</td></tr></table> |
| SERVICE ACTION RESERVATION KEY | If this field is 0, it is ignored. If the field is non-zero, the translation is in the following table: |

| | Service Action | Notes |
|---|---|---|
| | REGISTER/REGISTER AND IGNORE EXISITING KEY/REGISTER AND MOVE | The SNTL shall set the Reservation Register Data Structure NRKEY to the parameter list SERVICE ACTION RESERVATION KEY. |
| | PREEMPT/ PREEMPT AND ABORT | The SNTL shall set the Reservation Acquire Data Structure PRKEY to the parameter list SERVICE ACTION RESERVATION KEY. |
| | RESERVE/RELEASE/CLEAR | Unused |

| | |
|---|---|
| SPEC_I_PT | The SNTL shall only support translating this command if SPEC_I_PT parameter is set to 0 as reservations are applied on an NVMe Subsystem and not per I_T_Nexus; if set to 1, the SNTL shall terminate the command with CHECK CONDITION status, ILLEGAL REQUEST sense key, and INVALID FIELD IN PARAMETER LIST additional sense. |
| ALL_TG_PT | Ignored. NVMe Subsystem applies registration action to all controllers with the associated HOSTID. |

| | Service Action | Notes |
|---|---|---|
| APTPL | REGISTER/REGISTER AND IGNORE EXISITING KEY | If APTPL is set to 0b, Reservation Register command DWORD 10 CPTPL shall be set to 10b to request reservations and registrants are cleared on power on.

If APTPL is set to 1b, Reservation Register command DWORD 10 CPTPL shall be set to 11b to request reservations and registrants are persistent across power loss if the device supports this (refer to table 6-28, field PTPL_C). If the device does not support persisting reservations through power loss, the command shall be terminated with CHECK CONDITION status, |

| | | |
|---|---|---|
| | | ILLEGAL REQUEST sense key, and INVALID FIELD IN PARAMETER LIST additional sense.<br><br>If APTPL is set to 1b and device supports persistent reservations through power lost, the SNTL shall issue a Set Features Admin command for Reservation Persistence Feature ID 83h, with command DWORD 11 bit 0 (PTPL) set to 1 if it is not already set (refer to table 6-31, field PTPL_A) prior to issuing the Reservation Register NVM command. |
| | PREEMPT/<br>PREEMPT AND ABORT/<br>RESERVE/RELEASE/CLEAR/<br>REGISTER AND MOVE | Unused. |
| ADDITIONAL PARAMETER DATA | Unused | |

# 7 Status Mappings

Command statuses shall require translation from a NVM Express Status Code to a SCSI Status Code, Sense Key, and an Additional Sense Code where applicable.

## 7.1 Generic Command Status

Table 7-1: Generic Command Status Mappings

| NVM Express | SCSI | | |
|---|---|---|---|
| Status Code | Status Code | Sense Key | Additional Sense Code |
| Success Completion | GOOD | NO SENSE | |
| Invalid Command Opcode | CHECK CONDITION | ILLEGAL REQUEST | INVALID COMMAND OPERATION CODE |
| Invalid Field in Command | CHECK CONDITION | ILLEGAL REQUEST | INVALID FIELD IN CDB |
| Data Transfer Error | CHECK CONDITION | MEDIUM ERROR | |
| Commands Aborted due to Power Loss Notification | TASK ABORTED | ABORTED COMMAND | WARNING – POWER LOSS EXPECTED |
| Internal Device Error | CHECK CONDITION | HARDWARE  ERROR | INTERNAL TARGET FAILURE |
| Command Abort Requested | TASK ABORTED | ABORTED COMMAND | |
| Command Aborted due to SQ Deletion | TASK ABORTED | ABORTED COMMAND | |
| Command Aborted due to Failed Fused Command | TASK ABORTED | ABORTED COMMAND | |
| Command Aborted due to Missing Fused Command | TASK ABORTED | ABORTED COMMAND | |
| Invalid Namespace or Format | CHECK CONDITION | ILLEGAL REQUEST | ACCESS DENIED – INVALID LU IDENTIFIER |
| LBA Out of Range | CHECK CONDITION | ILLEGAL REQUEST | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| Capacity Exceeded | CHECK CONDITION | MEDIUM ERROR | |
| Namespace Not Ready (Do Not Retry bit value 1) | CHECK CONDITION | NOT READY | LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE |
| Namespace Not Ready (Do Not Retry bit value 0) | CHECK CONDITION | NOT READY | LOGICAL UNIT NOT READY, BECOMING READY |
| Reservation Conflict | RESERVATION CONFLICT | N/A | N/A |

## 7.2 Command Specific Status

Table 7-2: Command Specific Status Mappings

| NVM Express | SCSI | | |
|---|---|---|---|
| Status Code | Status Code | Sense Key | Additional Sense Code |
| Completion Queue Invalid | CHECK CONDITION | ILLEGAL REQUEST | |
| Invalid Queue Identifier | Unspecified | Unspecified | Unspecified |
| Maximum Queue Size Exceeded | Unspecified | Unspecified | Unspecified |
| Abort Command Limit Exceeded | CHECK CONDITION | ILLEGAL REQUEST | |
| Asynchronous Event Request Limit Exceeded | Unspecified | Unspecified | Unspecified |
| Invalid Firmware Slot | Unspecified | Unspecified | Unspecified |
| Invalid Firmware Image | Unspecified | Unspecified | Unspecified |
| Invalid Interrupt Vector | Unspecified | Unspecified | Unspecified |
| Invalid Log Page | Unspecified | Unspecified | Unspecified |
| Invalid Format | CHECK CONDITION | ILLEGAL REQUEST | FORMAT COMMAND FAILED |
| Conflicting Attributes | CHECK CONDITION | ILLEGAL REQUEST | INVALID FIELD IN CDB |
| Attempted Write to Read Only Range | CHECK CONDITION | DATA PROTECT | WRITE PROTECTED |

## 7.3 Media Errors

Table 7-3: Media Errors Mappings

| NVM Express | SCSI | | |
|---|---|---|---|
| Status Code | Status Code | Sense Key | Additional Sense Code |
| Write Fault | CHECK CONDITION | MEDIUM ERROR | PERIPHERAL DEVICE WRITE FAULT |
| Unrecovered Read Error | CHECK CONDITION | MEDIUM ERROR | UNRECOVERED READ ERROR |
| End-to-end Guard Check Error | CHECK CONDITION | MEDIUM ERROR | LOGICAL BLOCK GUARD CHECK FAILED |
| End-to-end Application Tag Check Error | CHECK CONDITION | MEDIUM ERROR | LOGICAL BLOCK APPLICATION TAG CHECK FAILED |
| End-to-end Reference Tag Check Error | CHECK CONDITION | MEDIUM ERROR | LOGICAL BLOCK REFERENCE TAG CHECK FAILED |
| Compare Failure | CHECK CONDITION | MISCOMPARE | MISCOMPARE DURING VERIFY OPERATION |
| Access Denied | CHECK CONDITION | DATA PROTECT | ACCESS DENIED – NO ACCESS RIGHTS |

# 8 Task Management Functions

Task Management Functions are requests by application clients affecting the processing of a SCSI commands. Support for Task Management Functions requires maintaining a mapping between the SCSI command issued by the application client and one or more NVM Express commands resulting from translation into NVM Express.

Table -8-1: Translation of Task Management Functions

| Function | Notes |
|---|---|
| ABORT TASK | May be supported by issuing an Abort command. |
| ABORT TASK SET | May be supported by issuing an Abort command on all outstanding commands. |
| CLEAR ACA | Unspecified |
| CLEAR TASK SET | May be supported by issuing an Abort command on all outstanding commands. |
| I_T NEXUS RESET | Shall be supported by returning FUNCTION SUCCEEDED if there are outstanding commands in the submission queue, otherwise by returning FUNCTION COMPLETE. |
| LOGICAL UNIT RESET | Shall be supported by writing a 0 to Enable (EN) field of Controller Configuration register. |
| QUERY TASK | May be supported. If specified command has one or more NVM Express commands queued resulting from translation than FUNCTION SUCEEDED shall be returned. Otherwise, FUNCTION COMPLETE shall be returned. |
| QUERY TASK SET | Unspecified |
| QUERY ASYNCHRONOUS EVENT | Unspecified |